Printed on Thin Paper for Foreign Circulation.

NOV 30 1921

Engineering Library

The Engineer.

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VOL. CXXXII.—No. 3438] LONDON: FRIDAY EVENING, NOVEMBER 18, 1921 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

TO CONTRACTORS ONLY.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Tuesday, 6th December, 1921, for the SUPPLY of :—

(1) ELECTRICAL
(2) MECHANICAL

ENGINEERING LABOUR IN DAYWORK in connection with the maintenance, &c., of installations in the Birmingham, Bristol, and Liverpool Districts during the period of one year from 1st January, 1922.

Forms of Tender and all particulars may be obtained on application to the CONTRACTS BRANCH, H.M. Office of Works, London, S.W. 1. 6690

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of LATHES.

Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Thursday, the 8th December, 1921.

T. RYAN,
6719 Director-General.

Iron and Steel Institute,
28, VICTORIA-STREET, LONDON, S.W. 1.

ANDREW CARNEGIE RESEARCH FUND.

The COUNCIL of the IRON AND STEEL INSTITUTE is prepared to receive APPLICATIONS for GRANTS in aid of Research Work on the Metallurgy of Iron and Steel.

The number of grants in any one year is limited to 5 or 6. The Council is not pledged to accept any particular application for assistance, but will give preference to those proposals which appear to them to be of the most practical advantage to the iron and steel and allied industries.

Proposals should be submitted before the end of February, 1922, on a special form to be obtained from the SECRETARY of the INSTITUTE. 6721

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
COAL-CUTTING MACHINES.

The Proprietor of British Letters PATENT No. 108,779 is PREPARED to LICENSE British Manufacturers to work under it. It relates to coal-cutting machines of the type provided with a haulage chain and comprises means for preventing the chain links jamming on the sprocket wheel.

Address: BOULT, WADE and TENNANT, 111 and 112, Hatton-garden, London, E.C. 1.
6689

PATENTS AND DESIGNS ACTS, 1907-1919.
PAPER-FEEDING APPARATUS.

The Proprietors of British Letters PATENT No. 22,761 of 1912 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to an improved paper-feed mechanism suitable for wrapping machines and the like.

Address: BOULT, WADE and TENNANT, 111/112, Hatton-garden, London, E.C. 1.
6720

Aberdeen Corporation Water-WORKS.
EXTENSIONS, 1920.

CONTRACTS Nos. 4 and 5.—NEW AQUEDUCT.

The Town Council of Aberdeen are prepared to receive TENDERS from competent persons willing to enter into contracts for the CONSTRUCTION of (a) about 1 Mile of 4ft. CONDUIT, partly in tunnel, (b) about 1 Mile of 4ft. CONDUIT.

The drawings may be inspected and specifications, schedules of quantities and forms of Tender obtained on and after 21st November, 1921, on application at the Water Engineer's office, 41½, Union-street, Aberdeen.

For each specification of each contract a deposit of Five Pounds sterling in cash will be required, which sum will, after a Tender has been accepted, be returned to the tenderer, provided that he shall have sent in a bona fide Tender, based on the drawings, specification and schedule of quantities provided, with the schedule of quantities and other schedules fully priced out in detail, and shall not have withdrawn the same. Provision is made for adjustment of the contract sum to meet alterations in the cost of labour and materials.

Tenders on the forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for New Aqueduct," and addressed to the undersigned, must be delivered not later than 9th December, 1921.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M.I.Mech.E.,
Water Engineer.

Water Engineer's Office,
41½, Union-street, Aberdeen,
9th November, 1921. 6669

Belfast Harbour.

The Belfast Harbour Commissioners are prepared to receive TENDERS for the CONSTRUCTION of a JETTY and DOLPHINS on the eastward side of the new Oil Berth, Musgrave Channel, Co. Down, all in accordance with drawings which may be seen at the office of the Harbour Engineer, Mr. T. S. Gilbert, M. Inst. C.E., from whom copies of the conditions of contract, specification, and form of Tender may be obtained.

Tenders must be made on the form provided for the purpose, and must be enclosed in a sealed envelope, endorsed "Tender for Jetty and Dolphins," and addressed to the undersigned and delivered not later than Monday, the 12th December, 1921.

The Commissioners are also prepared to receive ALTERNATIVE OFFERS for the above work in REINFORCED CONCRETE.

The Commissioners do not bind themselves to accept the lowest or any Tender.

D. J. OWEN,
General Manager and Secretary.

Harbour Office, Belfast,
11th November, 1921. 6691

The National Foremen's Associations of the ENGINEERING AND ALLIED TRADES.
(Registered under the Trade Union Act.)

An Association specifically formed to look after the Interests of Foremen in their Supervisory Capacity.

All communications to Head Offices,
H. W. REID, 95, Belgrave-road,
General Secretary. Victoria, S.W. 1.
Ex.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Limitation of Naval Armaments.

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The Newcomen Society.

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City and South London Railway Enlargement.

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The Motor Show.

Recent Developments in Power Station Design.—No. XVI.

PUBLIC NOTICES

Bombay, Baroda, and Central INDIA RAILWAY COMPANY.

The Directors are prepared to receive up to Noon on Wednesday, 7th December, TENDERS for the SUPPLY of :—

1. AXLE-BOXES FOR WAGONS.
2. STEEL FISH BOLTS, NUTS & WASHERS.
3. STEEL DOG SPIKES.

Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).

The Directors do not bind themselves to accept the lowest or any Tender.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1,
14.11.21. 6703

Great Southern and Western RAILWAY (IRELAND).
CONTRACTS, 1922.

The Directors of the Great Southern and Western Railway Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES for three months commencing 1st January, 1922, and alternatively for six months commencing the same date :—

	No. of Form.		No. of Form.
Acid, Sulphuric	3D	Glass and China Sundries	27B
Asbestos Sheeting, &c.	40	Hardware (Sundry)	17
Baskets	10	India Rubber Goods	9A
Bolts, Nuts, and Rivets	15	Implements, Sundry	21
Brooms and Brushes	13	Iron Tubes and Fittings	29
Brass Fittings for Carriages	18	Iron and Steel Wire	30A
Do. do. for Lamps	18A	Leather	12
Do. do. for Water	26A	Linen	8
Do. do. for Gas	26B	Locks and Keys	19
Canvas and Sacks	6	Mats, Fibre	16
Carriage Laces	7A	Nails	31
Castings, Mall. Iron	11	Oak Keys	35A
Cloth for Carriages and Uniforms	7C	Oak Trenails	35B
Clothing, Oil	9A	Packings	40
Do., I.R. proofed	9B	Plumbago	41
Coach Screws and Washers	15	Railway Fastenings (Iron)	16
Colours	2	Do. (Steel)	16A
Corks	39	Rain Water Pipes and Gutters	25
Cotton Waste	5A	Ropes, Twine, and Flax	4
Crucibles	41	Sewer Pipes, Plaster of Paris, &c.	32
Drysalteries	3	Shovels, Spades, &c.	21A
Emery and Glass Cloth, &c.	28	Soft Goods	8
Files and Tool Steel	20	Sponge Cloths	5
Fire-bricks and Clay	33	Signal Wire Pulleys	11
Foundry Requisites	42	Screws and Split Pins	14
Galvanised Sheets, Buckets, &c.	23	Tin-plates	22
Grates, Stoves, and Fenders	24	Waste, &c.	5A
Grindstones	28	Waterproof Clothing	9B
Glass, Sheet, and Plate	27A	Wicks	8
		Wire, Fence, and Signal	30A
		Wirework	30B

Forms of Tender can be obtained on payment of 1s. each from the Stores Superintendent, General Stores Department, G.S. and W.R., Inchicore, Dublin. Applications for forms by post must be accompanied by postal order, Stamps cannot be accepted. All inquiries for information should be also directed to the Stores Superintendent.

Patterns may be inspected at the General Stores Department on and after the 18th inst., between the hours of 10 a.m. and 4 p.m. (except on Saturdays).

Tenders must be enclosed in the special envelope supplied for the purpose with each schedule, and must be posted so as to be with the undersigned before 10 a.m. on Wednesday, 30th November, 1921.

The Directors will not consider any Tender unless it is furnished on the Company's form, and do not bind themselves to accept the lowest or any Tender.

By Order,
ROBERT CRAWFORD, Secretary.

Kingsbridge Terminus, Dublin,
November, 1921. 6697

PUBLIC NOTICES

South Staffordshire Waterworks COMPANY.

TENDER FOR THE LAYING OF 18IN. AND 24IN. STEEL PIPES, SOMERFORD TO BLOXWICH.

The South Staffordshire Waterworks Company invite TENDERS for the LAYING and JOINTING of about 16,000 LINEAL YARDS of STEEL WATER MAIN, 18in. and 24in. in diameter, from their intended Pumping Station at Somerford, in the Parish of Brewood, to Bloxwich, both in the County of Stafford, together with contingent works.

Forms of Tender, specification, bill of quantities, and schedule may be obtained from, and drawings inspected at, the offices of the Engineer-in-Chief on and after November 21st, 1921, between the hours of 10 a.m. and 4 p.m. daily, Saturdays excepted, upon the deposit of a cheque value Five Guineas, which will be returned on receipt of a bona fide Tender, together with the return of all documents supplied.

Sealed Tenders, endorsed "Tender for Somerford-Bloxwich Main," must be delivered to the undersigned not later than 10 a.m. on Monday, December 12th, 1921. The Company do not bind themselves to accept the lowest or any Tender.

FRED. J. DIXON, M. Inst. C.E.,
Engineer-in-Chief.

28A, Paradise-street, Birmingham,
November, 1921. 6699

Stourbridge Main Drainage BOARD.

TO STEAM BOILER MANUFACTURERS.

The Stourbridge Main Drainage Board invite TENDERS for the SUPPLY and ERECTION at their Sewage Pumping Station at Stourbridge of a 7ft. by 24ft. LANCASHIRE STEAM BOILER to carry a pressure of 180 lb., together with SUPERHEATER and WATER and STEAM CONNECTIONS.

Forms of Tender, general conditions, and specification may be obtained from Mr. W. Fiddian, the Engineer to the Board, Church-street, Stourbridge, on and after Monday, November 21st, on payment to the undersigned of £3 3s., which sum will be returned on receipt of a bona fide Tender on the form provided.

Sealed Tenders, addressed to me and endorsed "Tender for Steam Boiler," must be delivered at my office at or before Noon on Thursday, the 15th day of December next.

The Board do not bind themselves to accept the lowest or any Tender.

J. D. HARWARD,
Clerk to the Board.

High-street, Stourbridge,
November 11th, 1921. P4408

Stourbridge Main Drainage BOARD.

TO UNIFLOW ENGINE AND TURBINE PUMP MANUFACTURERS.

The Stourbridge Main Drainage Board invite TENDERS for PUMPING PLANT, consisting of a Uniflow Condensing Steam Engine, a Centrifugal or Turbine Pump and Accessories thereto, for their Sewage Pumping Station at Stourbridge, the capacity required being at the rate of two million gallons per day at a head of 190ft.

Forms of Tender, general conditions, specification, and drawing may be obtained from Mr. W. Fiddian, the Engineer to the Board, Church-street, Stourbridge, on and after Monday, November 21st, on payment to the undersigned of £3 3s., which sum will be returned on receipt of a bona fide Tender on the form provided, together with all incidental papers supplied therewith.

Sealed Tenders, addressed to me and endorsed "Tender for Pumping Plant," must be delivered at my office at or before Noon on Thursday, the 15th day of December next.

The Board do not bind themselves to accept the lowest or any Tender.

J. D. HARWARD,
Clerk to the Board.

High-street, Stourbridge,
November 11th, 1921. P4407

PUBLIC NOTICES

Wrexham and East Denbigh-SHIRE WATER CO.
SUPPLY OF 12IN. DIAMETER STEEL TUBES.

The Directors invite TENDERS for the SUPPLY and DELIVERY of approximately 18,000ft. of 12in. STEEL TUBES, with spigot and socket ends.

Full particulars may be obtained on application to the undersigned.

Sealed Tenders, endorsed "Tenders for 12in. Steel Tubes," to be delivered at the offices of the Company, Egerton-street, Wrexham, not later than 1st December next.

The Company do not bind themselves to accept the lowest or any Tender.

FREDERICK STORR,
Engineer and Secretary.

Water Offices,
Egerton-street, Wrexham,
8th November, 1921. 6642

Wrexham and East Denbigh SHIRE WATER CO.
12IN. CAST IRON PIPES.

The Directors invite TENDERS for the SUPPLY and DELIVERY of about 200 Tons of 12in. CAST IRON PIPES and SPECIAL CASTINGS (to the British Standard Specification).

Particulars may be obtained on application to the undersigned.

Sealed Tenders, endorsed "Tenders for 12in. Cast Iron Pipes," to be delivered to the offices of the Company, Egerton-street, Wrexham, not later than 1st December next.

The Company do not bind themselves to accept the lowest or any Tender.

FREDERICK STORR,
Engineer and Secretary.

Water Offices,
Egerton-street, Wrexham,
8th November, 1921. 6641

City of Birmingham Electric SUPPLY DEPARTMENT.
STEAM-DRIVEN ELECTRIC GENERATING PLANT FOR SALE.

The undermentioned PLANT, installed at the Corporation Electric Generating Station, Chester-street, Aston, Birmingham, is FOR SALE and IMMEDIATE REMOVAL :—

ONE 750 K.W. GENERATING SET, comprising a Yates and Thom Vertical Cross-compound Engine, with cylinders 25in. and 50in. diameter, 3ft. 6in. stroke, 93 revs. per minute, 150 lb. per square inch steam pressure direct coupled to a General Electric Co.'s multi-polar compound-wound direct-current Generator, 440-550 volts. The engine is complete with a Worthington surface condenser, air pump and circulating water pump.

The plant, which was installed in 1906, is in first-class condition and can be inspected or seen on load by appointment.

Permits to inspect and conditions of sale can be obtained on application to the undersigned, to whom all offers should be addressed :—

E. J. JENNINGS,
Secretary.

14, Dale-end, Birmingham,
8th November, 1921.

Bombay Port Trust.

The Trustees invite APPLICATIONS from Engineers possessing experience in Port, Dock, and Railway Construction and Maintenance for APPOINTMENT as their CHIEF ENGINEER.

The salary of the officer selected will be determined according to qualifications and experience.

The present salary of the appointment is Rs. 2750, rising by annual increments of Rs. 125 to Rs. 3000.

Under the Trustees' rules married officers are provided with house accommodation, for which rent at the rate of 10 per cent. of salary is charged.

Applications should be addressed in writing to the Consulting Engineers and Agents, Bombay Port Trust, 2, Queen Anne's-gate, S.W., and will be received up to the 1st December, 1921. These should be accompanied by a complete resume of applicant's professional career and copies of not more than three recent testimonials.

Age (preferably between 40 and 45 years) should be stated.

By Order of the Trustees,
A. J. BARRY,
WALTER C. HUGHES,
K. A. WOLFE BARRY,
Consulting Engineers and Agents.

14th November, 1921,
Dartmouth House,
2, Queen Anne's-gate,
Westminster, London. 6705

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PUBLIC NOTICES

Bombay, Baroda, and Central India Railway.

ASSISTANT CHIEF DRAUGHTSMAN.

The Directors are prepared to receive APPLICATIONS (by letter only) for APPOINTMENT as ASSISTANT CHIEF DRAUGHTSMAN in the Locomotive and Carriage Department of the Company in India. Age up to 30 years. Single men preferred.

Candidates must be capable of dealing with locomotive or carriage and wagon drawing-office work and must have served in the workshops of a railway company or large locomotive engine builders, and subsequently have had experience in any up-to-date well-managed drawing-office. They must possess good technical knowledge and must have undertaken a thorough course of instruction at an engineering college or large technical school, and must be capable of correctly calculating stresses in boilers, working parts of engines and machines, and in simple structural designs and girders. They must also be able to make the calculations usual in a locomotive drawing-office relative to tractive power, &c.

Terms: A three years' agreement in the first instance, second-class free passage to India and home again on satisfactory termination of services.

Salary: Rs. 425, rising by annual increments of Rs. 25 to Rs. 475 per calendar month.

The applicant selected will be required to pass a strict medical examination by the Company's consulting physician before appointment.

Letters, accompanied by a short record of applicants' career, showing in chronological order (with dates) where they were trained and subsequent experience, giving names of employers and class of work they have been employed upon from time to time, together with copies (not originals) of testimonials, should be addressed to the undersigned not later than the 26th November, 1921.

S. G. S. YOUNG,
Secretary.

Offices: The White Mansion,
91, Petty France, Westminster, S.W. 1.
10th November, 1921. 6700

West Kent Main Sewerage Board.

ENGINEERING CLERK OF WORKS REQUIRED at £8 per week, to superintend Sewage Disposal Works Extension Scheme at Dartford, Kent, including the construction of a deep-water ferro-concrete riverside wharf about 500ft. long, precipitation tanks, sewer, &c. Necessary assistance will be given.—Applications must be delivered to the SECRETARY of the SEWERAGE BOARD, Park House, Bromley, Kent, on or before Friday, 25th November, and must be made upon official forms obtainable from him. 6704

SITUATIONS OPEN

WANTED, an ASSISTANT to TECHNICAL DIRECTOR of a number of large firms. Must be university graduate holding engineering degree and have had some practical experience. Remarkable opportunity for man having strong personality, imagination, common sense and ambition.—Address, P4425, The Engineer Office. P4425 A

WANTED, ENGINEER, Not Over 30, Unmarried, used to Running Repairs of Diesel and other Crude Oil Engines, to TAKE CHARGE of PLANT in India. Salary Rupees 350 per month. Free furnished quarters, servants, second-class passage, and annual bonus.—Address immediately, 6730, The Engineer Office. 6730 A

WANTED, First-class TOOL MAKER to Take Charge of Large Tool Department producing special Automatic Machines, also Jigs and Fixtures of high grade. Only men who have held a similar position need apply. Liberal salary to the right man. State age and qualifications.
Address, "TOOL," Wm. Porteous and Co., Advertising Agents, Glasgow. P4391 A

WANTED, TWO or THREE ASSISTANT CONTRACTORS' ENGINEERS for temporary work. State details of experience, age, and if at liberty.—Address, 6728, The Engineer Office. 6728 A

A VACANCY OCCURS in a Large Engineering Works for an EXPERT FOUNDRYMAN, who would be required to act as a connecting link between the drawing-office, pattern shop and ironfoundry. Applicants must prove a first-class practical experience of up-to-date foundry practice, and be able to discuss matters of design, &c., with engineers and draughtsmen. The position is an attractive one, and offers great scope to a really capable man. Applications (which will be treated in confidence) should give full particulars of training and experience, positions held, age and salary required.—Address, 6711, The Engineer Office. 6711 A

CHIEF RATE FIXER WANTED for Large Engineering concern in the North of England; applicants must be well acquainted with the Working of Piecework Systems, capable of Supervising a large staff of Rate Fixers, and well experienced in Machining and Assembling Operations. Only really first-class men who have held similar positions elsewhere need apply. State experience (fully), age and salary required.—Address, 6710, The Engineer Office. 6710 A

ENGINEER REQUIRED IMMEDIATELY for Nigeria by Firm of Contractors, as General Assistant and to act for manager while on leave. Should have experience in Erection of Bungalows, Buildings, Coating, Eastings, and be capable of taking charge of large Sawmill. Mechanical experience an advantage. —Address, with full particulars and salary required, 6735, The Engineer Office. 6735 A

ENGINEER REQUIRED as ACTIVE DIRECTOR. Able to invest £1500-£2000 and control from Birmingham large area for a progressive London firm of Engineers and Machinery Merchants specialising in Heavy Plant. Excellent opening for a live man. Open fullest investigation.—Particulars from ARNOLD and CO. (London), Ltd., 143, Cannon-street, E.C. 4. 6701 A

ENGINEER, Under 30, Unmarried, WANTED for Baghdad for Engineering Sales and Supervision of Motor Repair Workshops. Sales and costing experience essential. Initial salary 1000 rupees per month, with quarters and benefits of Provident Fund.—State age, education, experience, war service, to K., Winchester House, E.C. 2. 6726 A

TECHNICAL and COMMERCIAL ASSISTANT, with ultimate promotion, for department handling a specialty in non-corrodible metals. Good opportunity and prospects for energetic technically trained man. State experience and give references.—Address, "TECHNICAL," Wm. Porteous and Co., Advertising Agents, Glasgow. P4561 A

YOUNG ENGINEER WANTED for Design and Superintending Erection of Petrol Pumping and Storage Plant. State age, experience, and salary required.—A.B.C., 20, Bucklersbury, E.C. 4. 6718 A

CHIEF DRAUGHTSMAN WANTED for Engineering Works in Wolverhampton District; good experience in Pumping Installation and General Steam Engine Work essential.—Address, stating experience and salary required, P4339, The Engineer Office. P4339 A

DRAUGHTSMAN (SENIOR), with All-round Experience in Lift Work; only thoroughly competent men need apply. State age, experience and salary required.—Address, P4388, The Engineer Office. P4388 A

FIRST-CLASS DRAUGHTSMAN WANTED, with experience in Design of Conveyors, Cranes, &c., preferred; must be thoroughly capable and able to carry through complete plants according to best possible practice. Reply by letter, stating experience and details of jobs responsible for, salary required, and usual particulars. Please do not reply unless in the first rank.—THE MITCHELL CONVEYOR AND TRANSPORTER CO., Ltd., 45-50, Holborn-viaduct, E.C. 1. P4414 A

FIRST-CLASS STRUCTURAL DRAUGHTSMAN; must be quick and capable of taking responsibility for all classes of Steel Structural Work and carrying out work in accordance with best possible practice. Reply by letter, stating experience and details of jobs responsible for, salary required, and usual particulars. Please do not reply unless in the first rank.—THE MITCHELL CONVEYOR AND TRANSPORTER CO., Ltd., 45-50, Holborn-viaduct, E.C. 1. P4415 A

FITTER and TURNER REQUIRED for Algeria, under 30. Two years agreement, passage paid.—Address full details, 6727, The Engineer Office. 6727 A

SITUATIONS WANTED

ADVERTISER, Having Held Positions of Works manager, works supt., foreman, REQUIRES BERTH; experienced in production of steam, gas, and oil engines, cars, motor craft, &c.; first-class testimonials, good organiser; moderate salary required.—Address, P4418, The Engineer Office. P4418 B

ADVERTISER SEEKS POSITION OF TRUST with good firm, where energy and ability are recognised; capable accountant, specialised costing, progress and stores organisation; several years' experience as chief clerk; excellent references.—Address, P4384, The Engineer Office. P4384 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT. Services available for New Year or possibly before.—Write, Z. M. 618, c/o Deacon's, Leadenhall-street, E.C. 3. 6665 B

CIVIL and MECHANICAL ENGINEER (32), 8 Years' experience as assistant engineer on dock and harbour works, 5 years war service (Captain i/c workshops and stores, Mechanical Transport), DESIRES RESPONSIBLE POSITION at home or abroad; passed A.M.I.C.E. examination.—Address, P4404, The Engineer Office. P4404 B

ELECTRICAL and MECHANICAL ENGINEER SEEKS POSITION at home or abroad; 3 years "shops" and test-bed, 2 years engineering school; sub-station and power station experience in this country and South Africa; construction experience in S. America; knowledge of Spanish; gas and Diesel engine experience.—Please address offers to P4387, The Engineer Office. P4387 B

ENGINEER DESIRES POST in Consulting Engineer's Office or similar position. Practical and technical training, steam plants and lay-out of mills, preparation of schemes and estimates. At present abroad, agreement terminating early in New Year. Age 28. Good references.—Apply, S. W. E., 26, Portland-crescent, Manchester. P4423 B

ENGINEER (29), 2 Years' Apprent., Internal Combustion engines, SEEKS further EXPERIENCE; would take post as fitting improver; has drawing-office experience and London Matric.—Address, P4426, The Engineer Office. P4424 B

ENGINEER (31), First-class Board of Trade Certificate, 10 years in present employ as sea-going engineer, DESIRES POSITION ASHORE in Consulting Engineer's Office; would be willing to invest; experience includes turbines and up-to-date marine work.—Address, P4576, The Engineer Office. P4576 B

ENGINEER (33), Skilled, Thoroughly Experienced all types I.C. engines, stationary, marine and road, heavy and light, and portable pumps; used to control; good address.—Address, P4399, The Engineer Office. P4399 B

ENGINEERS' INSPECTOR OPEN for FURTHER WORK; all classes during construction; any district.—J. LOWE, 97, Byron-avenue, London, E.12. P4317 B

ENGINEER, Mechanical and Electrical, 20 Years' technical and commercial experience, 2 years aeroplane design, competent draughtsman, used to control of men, SEEKS ENGAGEMENT.—Address, P4417, The Engineer Office. P4417 B

ENGINEER, Practical and Technical, Sound Knowledge of designing and workshop control, is ANXIOUS to JOIN a FIRM as MANAGER, with the object of manufacturing steel storage bins, lockers, office furniture. Advertiser is a hard worker and has a good London connection. Can carry out all duties from raw material to finished article. Rolling mill and extension experience. Opportunity offers good side line for firms interested.—Address, P4580, The Engineer Office. P4580 B

EXPERT IN REINFORCED CONCRETE (31 years of age), with great practical experience and sound technical knowledge, DESIRES NEW APPOINTMENT; has had the supervision of numerous complicated works, industrial premises as well as harbour works; best references; speaks English, Russian, German and Scandinavian languages.—Address, P4575, The Engineer Office. P4575 B

MECHANICAL ENGINEER, 13 Years' Good General experience as manager and foreman, also costing and travelling experience, SEEKS responsible POST any capacity.—Address, P4332, The Engineer Office. P4332 B

REQUIRED, APPOINTMENT by MECHANICAL ENGINEER at home or abroad; first-class B.T. certificate; ex-R.F. officer; used to handling of men and work generally.—Capt. ROBINSON, Buena Vista, Vergam-terrace, Fishguard. P4396 B

TRAINED ENGINEER, with Management, Technical and travelling experience, SEEKS POST as MANAGER or REPRESENTATIVE; active, young, alert; highest reference from present employers; at liberty immediately.—Address, P4385, The Engineer Office. P4385 B

WORKS MANAGER REQUIRES POSITION. Good experience in all branches of engineering; progressive, tactful organiser; good refs.—Address, P4402, The Engineer Office. P4402 B

YOUNG ENGINEER, B.Sc., A.C.G.I., Grad. Inst. Mech. E., Grad. Inst. Aut. E., 1 year in shops, 3 years college, age 21, DESIRES OPENING as JUNIOR DRAUGHTSMAN or ASSISTANT ENGINEER; moderate commencing salary.—Write, R. A. WILSON JONES, 55, Berkeley-road, Coventry. P4392 B

£10 OFFERED for Permanent SITUATION, Any capacity, by young engineer with erecting, maintenance, fitting, M/c shop and electrical experience; good refs.—Address, P4421, The Engineer Office. P4421 B

CHIEF DRAUGHTSMAN, with Good All-round experience on power plant and works lay-outs, used to control of staff, SEEKS RESPONSIBLE POSITION in the London district.—Address, P4397, The Engineer Office. P4397 B

DRAUGHTSMAN SEEKS POSITION in London; very neat and quick and good all round, also good surveyor and leveller.—Address, P4416, The Engineer Office. P4416 B

DRAUGHTSMAN (27), With Experience in Ordnance, cable machinery, telephone and telegraph apparatus, also jigs, tools and gauges, REQUIRES POST. —C. H., 39, Wernbrook-street, S.E. 18. P4419 B

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Einstein and the Theory of Relativity.

By Major H. J. JONES, O.B.E., R.A.O.C., A.M.I. Mech. E., A.R.C.S. &c.

No. I.

Introduction.

The theory of the relativity of physical measurement, popularly associated with the name of Albert Einstein, has done for the fundamental conceptions of physical science what the "Origin of Species" did for biology in 1859. It has taken the basic hypotheses implied by Newton's laws of motion, in a self-subsistent space and time, gravitation, and the conservation of energy, mass and momentum, and reduced them to such an entirely new and novel unity that all the old familiar landmarks of Newtonian dynamics seem to recede into shadows and fallibility. The subject, being one of measurement, has a pre-eminent interest for the engineer; for he, of all people, is most intimately concerned with the intrinsic relations that subsist between the various measuremental aspects of natural phenomena.

Since 1905, when Einstein published his work on "The Restricted Principle of Relativity," a considerable amount of literature on the subject has appeared, mainly in German; and we are now able to inquire to what extent Einstein has given the engineer new weapons wherewith to coerce the forces of Nature to the service of mankind; whether he has established anything as fundamental as the laws of thermodynamics, for instance; or whether his theory of relativity is merely a passing mode of scientific thought, which, having served the stimulating purposes of temporary illumination, will dim with age and pass away.

The theory of relativity in its inception and development naturally falls into two stages, namely: the restricted principle enunciated in 1905, and the masterly generalisation of 1915, called the general principle of relativity. The foundations on which the theory rests are quite easy to comprehend by the aid of elementary mathematics, but they introduce us to such paradoxical aspects of familiar phenomena that it requires an unusual amount of mental effort to follow with confidence the theory in its interpretation of physical reality. For it is difficult for us to avoid making mechanical and verbal images to assist our comprehension; and as, owing to our limited vocabulary and imagination specialised along Newtonian lines, we are forced to use words and phrases which have a strictly conventional meaning applicable only to classical mechanics and Euclidean geometry, we are apt to make the most misleading statements, because in relativity mechanics these words and phrases may have no meaning whatsoever. The development from the restricted to the general principle, which is Einstein's unique achievement, was effected by the highly abstract considerations of the Calculus of Invariants and the manifold geometries of Gauss and Riemann. But the general principle, in its broad outline as a mode of thought, is comparatively simple to understand, although its application to the solution of physical problems is certainly pregnant with mathematical terrors. Let us examine, then, the scope of the theory of measurement which is included in the principle of the relativity of all knowledge.

In the first place, it is necessary to state formally and precisely that relativity dynamics is concerned only with such properties of the dynamical and electro-dynamical world as can be localised in terms of distance and time, and thus be measured with physical apparatus. In other words, it deals with the relations between the circumstances of an observer, his measuring scales, and the event or object measured. The phrase "circumstances of an observer" is intended to include all relevant data concerning the position, velocity, acceleration, and direction of motion of the observer relatively to the event or object measured. Relativity dynamics neither states nor implies that there are no other properties of the world, or that a complete description of world events is given or can be given only in terms of measurements taken with physical apparatus. Most of the mystery and apparent paradox associated with statements based on relativity principles arises from the neglect to remember this restricted scope and subject, and to the lack of a suitable vocabulary, which, unless the greatest care be exercised, forces us to use words which carry impossible implications.

Thus when "the shortest interval between two events" is spoken of, the word "shortest" does not mean "minimum" as Euclid would have meant it, namely, by measurement with a rigid scale, but "the most direct;" in fact, it is the *maximum* value of a certain integral which by its very constitution cannot be measured by a rigid scale at all. Similarly, when Minkowski states that the world-line of a particle moving with uniform velocity is a straight line, all he means is that the differential equation connecting the space and time co-ordinates of the particle is a linear one. Relativity dynamics, in short, no more completely describes physical phenomena than a statement of the relations and distances moved by the pieces describes a game of chess, or the chemical constitution of protoplasm describes life.

The ideas embodied in the standpoint that all knowledge is necessarily relative to the observer and his circumstances are not new. They are at least 2000 years old. But, until Einstein appeared, they were distinctively elusive and qualitative in character. The revolution in thought which he has brought about consists in the fact that in certain branches of physical knowledge, and by implication in all others, he has given a definite quantitative aspect to relativity, with the possibility of measuremental verification by the ordinary procedure of experimental physics. By the use of a powerful calculus he has been able to indicate the method by which we can segregate without ambiguity what is essential and what is irrelevant, what is intrinsic, and what is relative in the physical measurement of natural phenomena. He has, in fact, furnished us with a criterion by means of which we can determine how the physical measurement of anything connected with an event or an object is coloured by the unique circumstances under which the measurement is made. He has furnished us, not so much with natural laws, as with the criterion by which the integrity of natural laws is to be tested.

In all measurement certain differences arise, due to personal bias in the observer, errors of instrumental manipulation and adjustment. But relativity is concerned with none of these differences. Its scope is much more fundamental, for it deals with the basic character of the measurements taken by ideal observers with ideal instruments, having any sort of motion relatively to each other, and not in communication for the purpose of synchronising their clocks or calibrating their scales.

It appears that there are illusions of measurement just as there are illusions of optics; the unique circumstances of speed and relative position of any one observer automatically introduce certain irrelevances into his measurements, which, while totally undiscoverable by any physical test he himself can apply, are partly discoverable by another observer under different relative conditions of motion, &c. Thus it is commonly stated that on the theory of relativity no material body can have a velocity greater than that of light; but what is meant is that no material body will seem to have a velocity greater than that of light *when measured with optical apparatus*. In the case of the cathode rays and β particles we actually have matter moving at about 167,000 miles per second, so that particles moving to the right have a velocity of 334,000 miles per second relatively to those moving to the left, taking relative velocity to have the meaning it has in Newtonian dynamics. But what the theory of relativity proves is that if the velocity of the β particles moving to the left were *measured* by an observer having the speed of the β particles moving to the right, the measured speed could not exceed 186,000 miles per second, namely, the velocity of light. This result will become apparent later when the mathematical aspect of the compounding of velocities is dealt with; but the example provides an excellent illustration of the misleading statements with which the exposition of relativity abounds. What the theory proves is that relative velocities greater than that of light cannot be measured with optical apparatus, not that relative velocities of such magnitude cannot exist or be conceived, which is quite a different story.

It has been mentioned above that in the development of the general from the restricted principle of relativity, extensive use, by analogy, is made of the extremely abstruse qualitative relations of the manifold geometries established by the Göttingen School of Gauss, Riemann, and Minkowski, and to the engineer this procedure is apt to give an uneasy feeling that there is a subtle flaw somewhere. For, he asks, "What can the constructive idealism of a geometry of many dimensions have to do with physical reality? Is not the mind of man merely taking out of Nature just those special relations which are mentally satisfying to him because of their simplicity and symmetry? What possible connection can man-made Gaussian numbers, tensors, and the theory of invariants have with the dynamics of the universe or the constitution of the Zodiacal Light?"

The Beginnings of Relativity.

In order to appreciate the revolution in physical thought brought about by Einstein, it is necessary to review the position into which certain fundamental problems of physics had been brought by two centuries of guesswork and *ad hoc* hypothesis.

In 1728 Bradley discovered the phenomenon of stellar aberration, and on the corpuscular theory gave the immediate explanation by assuming that the air in the telescope, in which the stellar light was received, did not communicate any of its motion to the light passing along it. Young, in 1804, on the undulatory theory of light, gave a similar explanation; the æther being assumed by him to pervade all material objects just as air pervades a grove of trees.

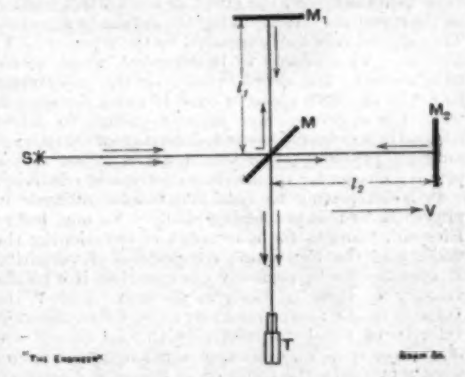
The following questions now arose: "What was the effect on the æther brought about by the movement of these material bodies? Was the æther convected by the motion, or was it entirely stagnant and unaffected? And if it were stagnant, was it possible to measure the velocity of the bodies relatively to this all-pervading ætheric medium?"

Now it is easy to show, on the undulatory theory of light, that the index of refraction of a transparent body, such as glass, is equivalent to the ratio of the velocity of light in the air to its velocity in the glass. If, then, we move the glass towards the incident light so that the relative velocity of the light to the glass is increased, and if we assume, as Arago, who performed the experiment, did, that the velocity of the light in the glass is constant and determined solely by its molecular constitution and not by its motion, then the index of refraction should be increased by movement towards and decreased by movement away from the source of light. Arago, to his astonishment, however, found that the index of refraction was not so affected. Fresnel, to whom he referred the problem, suggested that the negative result of the experiment could be explained if the assumption were made that the æther in the glass only partook of a very small proportion—about 1 per cent.—of the motion of the glass. This suggestion was, of course, pure guesswork and came to be known as Fresnel's convection coefficient. The occasion is notable as giving the first significant suggestion that the measured optical properties of matter were modified by motion relatively to the æther, which was conceived, generally, to be at rest.

In 1851 Fizeau attempted a verification of Fresnel's hypothesis by passing a beam of light along a tube through which water was circulating. The observations were consistent with Fresnel's hypothesis. In 1881, however, Michelson undertook a re-examination of the question by a method that avoided the complications introduced by the optical properties of transparent media. The 1881 experiment was repeated in 1887 by Morley, and again in 1905 by Morley and Miller, with increasing refinement. But the results were as negative as Arago's had been.

In case the purpose and details of the Michelson experiment may not be familiar to engineers, the following description is given to make them clear. It must be remembered that up to about the date of the experiment physicists had erected a most imposing theoretical structure on the basic assumption of a luminiferous æther to which they had given the most amazing physical properties. So much so that, to an engineer, it must have seemed like nothing on earth, and have asked of him the exercise of that faith which makes little children believe in the reality of fairies. One of the strangest characteristics of this æther was that it remained absolutely stagnant—that material bodies, transparent and opaque, moved through it without dragging it along or disturbing it in any way. The question, therefore, naturally arose: "How can the velocity of the earth relatively to this dead sea of æther be measured?" Clerk Maxwell indicated the method, which Michelson and Morley put into practice. The principle of their method will now be described.

They mounted a system of sixteen mirrors on a block of stone carried on a wooden platform which was floated in mercury, so that the whole apparatus



could be turned in any horizontal direction without mechanical strain. A parallel beam of light obtained from a source S—see the accompanying diagram—was directed on to a half-silvered mirror M which was so inclined that part of the beam was reflected through a right angle to a second mirror M_1, while part passed straight on to a third mirror M_2. These mirrors, M_1 and M_2, then reflected the light back again to the inclined mirror M, the beam from M_1 passing straight on through the unsilvered portion, and the beam from M_2 being reflected through a right angle. The two reflected beams were thus brought parallel with each other, and when superimposed could be viewed in a telescope T. (Only three mirrors are shown; actually several reflections from sixteen mirrors were made.) The whole apparatus was turned until the direction of one arm, say, $M M_2$, was approximately parallel with that of the earth's orbital motion, the magnitude of which we will assume to be V relatively to the æther. The problem was to measure V in terms of the velocity of light; or, looked at in another way, to find out what effect a variation of V had on the measured velocity of light.

Now, in accordance with Newtonian dynamics, if c be the velocity of the beam of light, *relatively to the æther*, when passing from M to M_2, and if V be the velocity of M_2, *relatively to the æther*, arising out of the motion of the earth, then the velocity of the light relatively to the arm $M M_2$ is $(c - V)$, and the time taken to pass from M to M_2 is $\frac{l_2}{(c - V)}$, where l_2 is the

length of the arm M M_2. On the return journey from M_2 to M the relative velocity is $(c + V)$, and the time taken $\frac{l_2}{c + V}$. Consequently, the total time for the light to travel from M to M_2 and back again is

$$T_2 = \frac{l_2}{(c - V)} + \frac{l_2}{(c + V)} = \frac{2 l_2 c}{(c^2 - V^2)}.$$

The relative velocity of the light passing from M to M_1 is $\sqrt{c^2 - V^2}$, for the light moves from M to M_1 with a velocity c relatively to the æther, and the arm M M_1 is moving at right angles to its length with a velocity V. Hence the time taken to go from M to M_1 and back again is—

$$T_1 = \frac{2 l_1}{\sqrt{c^2 - V^2}}$$

Thus although the two beams left the mirror M at the same instant, they arrived back again at times differing by

$$(T_2 - T_1) = 2 \left(\frac{l_2 c}{c^2 - V^2} - \frac{l_1}{\sqrt{c^2 - V^2}} \right)$$

Optically, this difference in the times of arrival means that the waves are in different phases when they arrive at M, and that when they are superimposed interference bands will be formed, which will be seen and measured in the telescope T.

The whole apparatus is now turned through 90 deg., so that the arm M M_1, originally at right angles to the earth's orbital motion, is made parallel with it. Under these circumstances the difference in the times of arrival of the two beams will be—

$$(T_2^1 - T_1^1) = 2 \left(\frac{l_1 c}{c^2 - V^2} - \frac{l_2}{\sqrt{c^2 - V^2}} \right)$$

Now, in general, this second time difference is not equal to that calculated for the first orientation, so that the interference bands in the second orientation of the apparatus will not be in the same position as they were in the first. The shift of their position will provide us with the means of calculating V in terms of c. The apparatus in the refined experiment was delicate enough to indicate the shift of the interference bands caused by a value of V of about 2 miles per second; so that the earth's speed of over 18 miles per second should have been observable with ease. No shift whatever was observed; in other words, contrary to theoretical prediction, $(T_2 - T_1)$ appeared to be the same as $(T_2^1 - T_1^1)$.

The outstanding feature of this negative result needs to be emphasised. According to Newtonian dynamics a measurable shift of the interference bands should have been observed; but whereas in the 1881 experiment the observed shift was less than one-fortieth part of the calculated shift, in the refined 1905 experiment it was less than one two-hundredth part, which means that, allowing for unavoidable experimental errors, the effect of the earth's motion on the measured velocity of light could not be detected. The relative velocities expressed by the terms $(c - V)$ and $(c + V)$ appeared to be identical, which seems to be absurd. The complete failure of this experiment to detect an earth speed of over 18 miles per second, when the apparatus was delicate enough to detect a speed of 2 miles per second, caused great excitement amongst physicists, and was destined to act as the priming charge for the modern doctrine of relativity.

It is interesting to note the mental attitude of physicists to this perplexing riddle. No one, before Einstein, thought for a moment of questioning the validity of the Newtonian composition of velocities. It appeared to be perfectly obvious that if c be the velocity of light *relatively to the æther* and V the velocity of the mirror *relatively to the æther*, then the velocity of the light relatively to the mirror was $(c - V)$ or $(c + V)$, according as the light and mirror were moving in the same or in opposite directions. Consequently in order to retain the hypothesis of a stagnant æther, and yet account for the fact that the velocity of the earth relatively to it could not be measured, a new hypothesis had to be introduced. In 1892 Fitzgerald invented what became known as the Fitzgerald contraction hypothesis. Later, in 1895, Lorentz had recourse to a similar hypothesis in connection with his electro-dynamical theories of matter.

In the Michelson experiment the length of one arm, say, M M_2 was obtained by mounting a set of mirrors, on a sandstone base, whereas the other arm M M_1 was obtained by mounting a set of mirrors on a wooden arm. As the whole apparatus was made to float in mercury, either the sandstone arm or the wooden arm could be made parallel with or at right angles to the direction of the earth's motion at will.

Now, Fitzgerald, accepting the calculated values of the time differences $(T_2 - T_1)$ and $(T_2^1 - T_1^1)$ as correct, nevertheless had to account for the fact that the difference between them completely escaped measurement. He did it, not by questioning the validity of Newtonian dynamics from which the expressions were derived, but by making the highly artificial assumption that the lengths of the arms, l_1 and l_2, were not invariable—that an arm, when lying parallel with the earth's motion, was shorter than when lying at right angles to it. Obviously, by assuming artificial changes in l_1 and l_2, when the apparatus is turned round, he was able to make $(T_2 - T_1) = (T_2^1 - T_1^1)$ without much trouble. Further, it should be noted that this hypothesis, introduced *ad hoc*, required not only that the arm should be shortened, but that the contraction should be independent of the properties of the substance of which the arm was composed, even when the materials differed so widely in structure and elasticity as sandstone and pitch pine. Despite these obvious difficulties, however, the contraction hypothesis was accepted as sufficient to explain the facts, on much the same grounds as Fresnel's convection coefficient had been, and it formed the second occasion on which the measured properties of matter—in this case the mechanical properties—was assumed to be modified by mere motion.

The next stage began with the pioneer work of Larmor and Lorentz in building up a conception of the structure of matter from the electro-magnetic standpoint. All matter was conceived to be made up of electrons which were assumed to be small indivisible nuclei carrying an electric charge. These nuclei were assumed to be in a state of vibration within the boundary which their aggregate made, and the movement of these charged nuclei were regarded as sufficient to set up an electro-magnetic field in accordance with the Maxwellian equations. Lorentz showed that one of the circumstances necessary in order to determine the motion of these electrons was a knowledge of the distribution of the charge on the surface of the electron, and that if, when an electron was at rest, its shape were spherical and the charge uniformly distributed, then theory required that, when moving, the dimensions of the electron parallel with the direction of motion must be reduced in exactly the same proportion as that required by Fitzgerald for the sandstone or wooden arm of the Michelson experiment. It will be seen that from different angles of approach, the one from the point of view of gross matter, and the other from that of the hypothetical electrical element, both Fitzgerald and Lorentz had been led to enunciate a physical contraction hypothesis of a most artificial character. In any case we may take Lorentz as giving the third notable example of an assumption that the properties of matter were modified by mere motion.

The contraction hypothesis, introduced, as we have seen, purely *ad hoc*, held the field until Einstein appeared and massacred it with many other innocents, despite the fact that all mechanical, optical and electrical experiments had consistently failed to give the hypothesis the slightest direct confirmation. Neither Rayleigh and Brace's experiment to detect double refraction in an isotropic body contracted by its motion; nor that of Trouton and Noble to detect directional forces in a charged condenser; nor that of Trouton and Rankine to find a difference of conductivity in directions inclined to that of motion, gave any indication whatever of a real physical contraction which is what the Fitzgerald-Lorentz contraction was taken to imply. Einstein, however, by going back to a scrutiny of first principles and assumptions hoary with the dust of ages, was able to give a rational explanation of the observed facts without making any arbitrary assumptions as to the constitution of matter, or its physical behaviour when in motion. The contraction hypothesis is now no longer necessary, for Einstein has shown that all experiments such as those of Michelson must give negative results purely from qualities inherent in our system of measurement when we use waves of light as our gauge of magnitude for space and time relations.

Even to-day it is often asked whether the Fitzgerald-Lorentz contraction is a real or a subjective one. Lorentz seems to think that it is real. But the answer is surely given when we say that had Einstein's principle of relativity been available in 1892, there would have been no need to invent the contraction hypothesis at all, and that at the present time it is superfluous and without meaning.

Developments in Power Station Design.

No. XVI.*

THE adoption in modern power stations of large boilers, each having single multiple-retort stokers, operating in conjunction with an undivided archless furnace, is fairly common practice. In stations containing turbo-generators rated at 10,000 kilowatts or over, large boilers devoid of brickwork arches have given very good results. A list of eighteen typical large modern plants, brought to our notice by Erith's Engineering Company, Limited, of 83, Kingsway, W.C. 2, shows that in all but one of these stations each boiler has a single electrically driven stoker working on a single furnace, with four straight walls, as no brickwork arches are required to complete combustion. Every boiler in the list has more than 10,000 square feet of heating surface, irrespective of the superheater and economiser. In all, there are 143 large unit boilers, with 151 stokers and 2169 retort units. The boilers have been built by eight different firms, and the commercial evaporating duty per stoker varies from 40,000 lb. to 80,000 lb. of high-pressure superheated steam, according to the size of the stoker. Some of the plants are provided with a large excess of boiler heating surface, instead of the usual economiser. In the case of the Paris station, which contains seven 35,000-kilowatt generating sets, two large stokers are placed on each double-ended furnace, an arrangement involving two overhead coal bunkers. Generally, however, it is preferable to place two such stokers under two separate single-ended boilers, so that they can be supplied by a single overhead bunker, and so that each stoker is entirely independent. In all cases in which this system of firing has been applied to water-tube boilers, the furnace has only four straight walls, even when the stoker is 30ft. wide and composed of eighteen self-cleaning retort units—as shown in Fig. 77—burning normally, say, 6 tons of slack coal hourly and generating hourly, say, 80,000 lb. of high-pressure superheated steam from a single boiler equipped with one of these multiple retort stokers. As most engineers are aware, with this retort method of firing the work is evenly divided over all the retort units. The coal is fed by a ram into the upper end

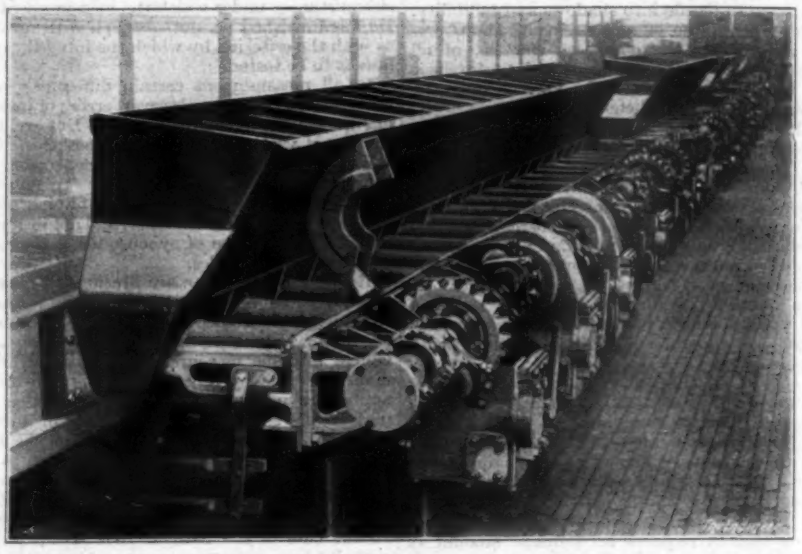


FIG. 77—SELF-CLEANING MULTIPLE RETORT ERITH-ROE STOKERS

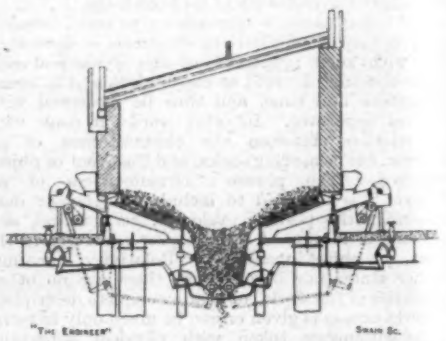
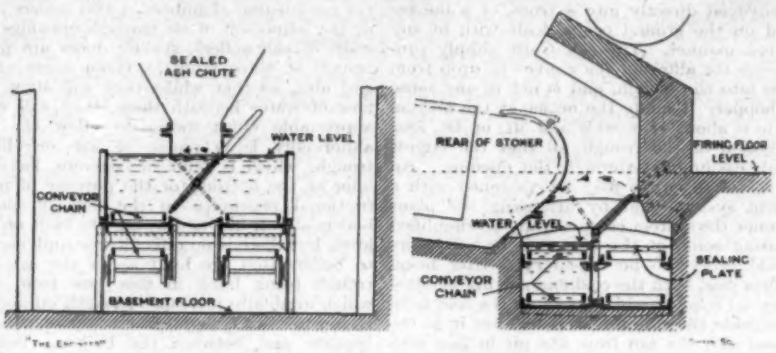


FIG. 78—METHOD OF CONTINUOUSLY DISCHARGING ASHES

* No. XV. appeared November 11th.

of each inclined retort, which is full of unburnt coal, and the coal is fed continuously into the fire zone, and is ignited as it passes upwards and over the air-supplying tuyeres, which positively distribute the air necessary for combustion. The lower layer of the thick fuel bed is the ignition and coking zone, whilst the final stage of high-temperature combustion is completed in the upper layer of the thick fire bed. There is consequently no need for fire-brick arches to complete combustion. The incandescent surface of the fuel bed radiates direct to the boiler tubes, which form the roof boundary of the archless furnace, and this instantaneous transfer by radiation of a large proportion of the heat units in the fuel is claimed to make it possible to maintain under all loads and under continuous working, economical high-temperature combustion with all classes of fuel. The incombustible residue or ash is continuously discharged from each self-cleaning retort unit, and it is said that cheap and fine low-grade coals are burnt with almost as high a thermal efficiency as high-grade coals. There are, we are told, power stations which under favourable load conditions generate with multiple retort stokers fitted to large boilers a kilowatt-hour for 20,000 British thermal units or less, corresponding to about 1¼ lb. of good coal or 2 lb. of low-grade coal. The automatic stoking and coal handling also eliminate manual labour, and thus reduce working costs. Such results, the makers of these stokers contend, are very close to the best theoretical results and leave no appreciable margin for further economy. The archless furnace also makes it a simple matter to fit burners for firing with oil or gas.



FIGS. 79 AND 80—EXAMPLES OF WATER-SEAL ASH-REMOVAL EQUIPMENTS

Until recent years makers of retort type stokers accumulated the incombustible ash in the furnace, and dumping or cleaning operations were carried out periodically. The rapid development of large boiler units has made it necessary to discharge the ash continuously, and one method of doing this is shown in Fig. 78. A large and deep ash pocket is formed at the centre of the boiler furnace, and beneath this pocket there are slow-moving toothed roller ash grinders. After the ash has had time to be thoroughly cooled or quenched during its slow descent down this large ash pocket, it is mechanically discharged by the mechanical action of this ash grinder, which extends across the centre of the double-ended furnace fitted with a duplex multiple retort stoker. This mechanical device for continuous ash discharge from a duplex inclined stoker was developed in 1913 at the Detroit Edison plant, and is now being fitted to the twelve large "Springfield" boilers with a heating surface of 18,900 square feet each at the Hell Gate plant of the New Edison Company, and also to the eight boilers with a heating surface of 15,290 square feet of the West Penn Power Company, at Springdale. Each boiler has in each of these instances a duplex thirteen-retort stoker, operating on a furnace 23ft. wide and 17ft. deep. In American power stations, using an unvarying supply of coal of the highest grade, this mechanical method of continuous ash discharge has proved satisfactory, but the makers of the stokers—Erith's Engineering Company, Limited—contend that it is unsuited for European and other stations which are supplied with various grades of fuel obtained from many different sources. A much simpler method of continuous ash discharge has been adopted for use in connection with the British-built Erith Roe stokers. The furnace extends to the full depth of the boiler, but there is no need to use a duplex stoker. A single stoker is employed, and it is of sufficient length to burn the coal to a clinker in a single continuous operation as it travels down the inclined retorts. As each unit composing the fire bed is continuous and mechanically sliced, and as an

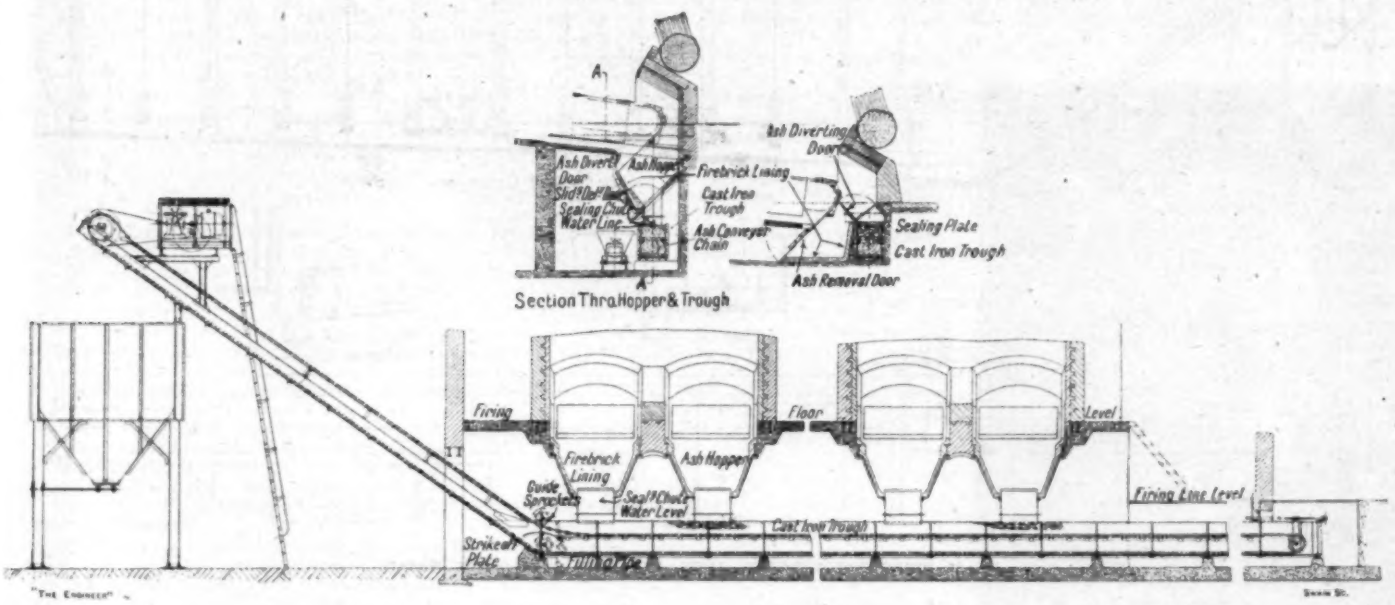


FIG. 81—ARRANGEMENT OF WATER-SEAL ASH-REMOVAL EQUIPMENT

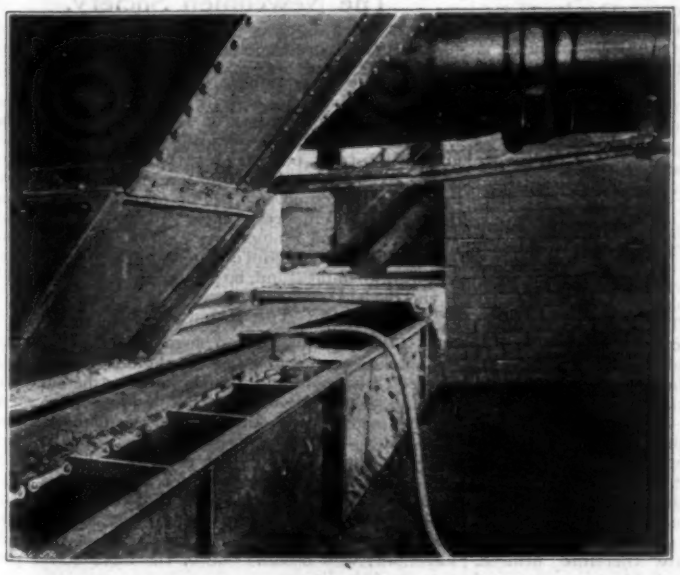


FIG. 82—DOUBLE ASH-CONVEYOR TROUGH IN BASEMENT OF BOILER HOUSE

FIG. 83—INTERIOR OF FURNACE SHOWING CONVEYOR TROUGH

adjustable motion is provided to suit the nature of the coal, the formation of large clinkers is avoided. According to an article which appeared in the *Electrical World* of August 27th, 1921, a marked improvement in the plant efficiency of the Edison Illuminating Company, of Boston, has recently been secured. The coal consumption per kilowatt-hour generated fell from 1.83 lb. in September of 1920 to 1.435 lb. in April, 1921. The turbo-generators having an output of about 30,000 kilowatts, together with the highly efficient boiler plant with multiple retort stokers, in the company's principal station at L-street, South Boston, are giving excellent results.

As regards the handling of ashes, several improvements in this direction have recently been made. The Underfeed Stoker Company has introduced an ash conveyor for the removal of ashes and clinker from furnaces automatically and continuously, which maintains an air seal in the combustion chamber, quenches the ashes as they fall from the furnace, prevents dust, fumes and heat from reaching the ash tunnel, dispenses with manual labour, improves the efficiency of the boilers by obviating air leakage and does not necessitate building the boilers above the ground level, as the conveyor can be arranged in the setting. The equipment has been designed specially to meet the requirements of modern boiler-houses, which are continually increasing in size and which must utilise fuel containing a very much larger percentage of ash than hitherto. Essentially, the equipment consists of a scraper or drag link conveyor working in a trough situated beneath that part of the furnace where the ash is delivered, and, in the case of a grate fitted with a travelling grate stoker, under the rear end. The ashes are delivered from the stoker into a chute, the end of which being below the water with which the trough is filled and in which the conveyor operates. The standard method of installing the equipment is shown in Fig. 79, where two conveyor chains are to be seen working in a single trough provided with a hinged door which serves to direct the flow of ashes coming through the chute on to one or the other of the chains, according to which happens to be in operation, the trough being so designed that either of the chains can be removed without dismantling any other part of the gear. As a rule, the trough is composed of strongly ribbed cast iron plates, and it extends the whole length of the boiler-house and at a height of about 2ft. It may be supported on trestles from the basement floor, as shown in Fig. 79, and in that case the chain usually runs on rollers underneath the trough. When, however, boilers are built on the ground level and there is no basement or tunnel beneath them the trough may be built into the boiler setting, as shown in Fig. 80, an arrangement which results in a considerable saving in the cost of the boiler-house. Where a duplex conveyor is considered unnecessary, a single conveyor may be used, as shown in the right-hand upper section in Fig. 81, with an alternative outlet on the chute, so that the ashes may, if necessary, be discharged on to the floor of the tunnel, from which they may be removed by other means. The schemes shown in Figs. 80 and 81 necessitate the passage of the ash and clinker through the return chain on to the lower or operative part of the chain, and the spaces between the chains and that between the cross bars are sufficiently large to deal with any size of clinker that is likely to be discharged. The ends of the trough are inclined upwards, so that the trough may contain sufficient water to seal the ends of the ash chutes. Obviously, as the ashes fall from the furnaces, they are quenched and dust and fume troubles are eliminated. At the delivery end of the conveyor the chain may be extended in an upward or horizontal direction for any distance, and without the use of additional mechanism, so that the ashes may be conveyed directly into a truck or a bunker or be piled on the ground or be dealt with in any other desired manner. The ash chute simply provides a means for allowing the clinker to drop from the furnace into the trough, and is not in any sense a storage hopper. Usually the outlet at the bottom of the chute is about 18in. wide and 3ft. or 4ft. long in the direction of the trough, so that the largest clinker may easily pass through the opening. An ash conveyor of this type may be combined with a coal-handling system, and by arranging the plant in this manner the system can generally be simplified by eliminating some of the elevators or conveyors which would otherwise be necessary. After being delivered into pits, both the coal and ash are handled by an overhead telpher, which picks up the coal from the pit alongside the siding and distributes it to the bunkers, and also the ash from the pit in line with the ash conveyor trough, and delivers it into a small bunker, where an inclined chute deposits it into an empty wagon on the same siding. Obviously, the system may be modified to meet varying conditions, but a combination plant built on the above lines will, it is said, generally be found to lessen the capital cost and the costs of power and labour. The speed of the conveyor chain varies according to the amount of power to be handled and to the width of the chain provided, but usually it does not exceed 10ft. per minute. Fig. 82 shows a double conveyor trough in the basement of a boiler-house. One leg of the chute has been removed in order to show the diverting door. A view of the interior of a furnace showing a travelling grate partly erected and one of the two conveyor troughs and diverting door is given in Fig. 83. The drawing, Fig. 81, shows the conveyor installed in a station where the boilers are on two levels. Where there is no basement, the trough is arranged immediately below, and at the rear of the the stoker settings, and it then passes into the basement below the boilers, which are built on a higher level, and from this level the conveyor eliminates the ash and delivers it into a receiving hopper outside the boiler-house.

Another and very simple system which has been devised by the Underfeed Stoker Company for this purpose is shown in Fig. 84. The ashes are continuously delivered from the ends of the travelling grates into an inclined trough, in which a stream of water of, say, about 40,000 gallons per hour is allowed to flow. The water carries the ash and clinker down the incline and delivers it into a sump, which has an area of sufficient size to allow the bulk of the ash to settle out, and the water runs through a screened opening into a suction pit, from which it is drawn and returned to the upper end of the trough by means of pumps. As this water is in continuous circulation, it naturally contains some of the lighter parts of the ash, and special centrifugal pumps are therefore utilised. Moreover, as certain parts are liable to erosion and will occasionally require attention, duplicate pumps are installed, so that whilst one pump is being attended to, the other can do the work. Having been delivered into the sump at the end of the trough, the ashes may be removed by any desired method, and one suitable arrangement is shown in the drawing. An alternative scheme is to provide an overhead telpher with a grab for periodically excavating the ashes and for loading them into railway wagons. The telpher can also be used for handling the coal. Another method is to deliver the ashes with the water into any large pit that may be available, such as a clay pit. To avoid any intercommunication between the combustion chambers of two boilers in a battery or the admission of air through openings in the side walls of the boilers, sealing doors are fitted in the trough at three points. These doors are weighted and hung so that, whilst they will allow the normal flow of water beneath them, they will without any appreciable effort swing to allow the passage of abnormally large pieces of ash or clinker. The trough, which is built in concrete, has a cast iron liner at the bottom for the purpose of reducing the frictional resistance to the flow of clinker. The boilers shown in the drawing are built on the ground level, but there is no difficulty in applying the system to boilers that are built above the ash tunnel, the trough being hung in this case from ash chutes, which gradually increase in length on account of the incline of the trough, and being open between the hoppers and between the boilers. Sealing doors, similar in principle to those shown in the drawing, would be provided between the hoppers and the boilers. The advantages of this system are that there are no working parts beneath the boiler, the ash is taken away continuously, there are no dust or fumes or heat in the ash tunnel, and a minimum amount of labour and power is required for the operation of the plant.

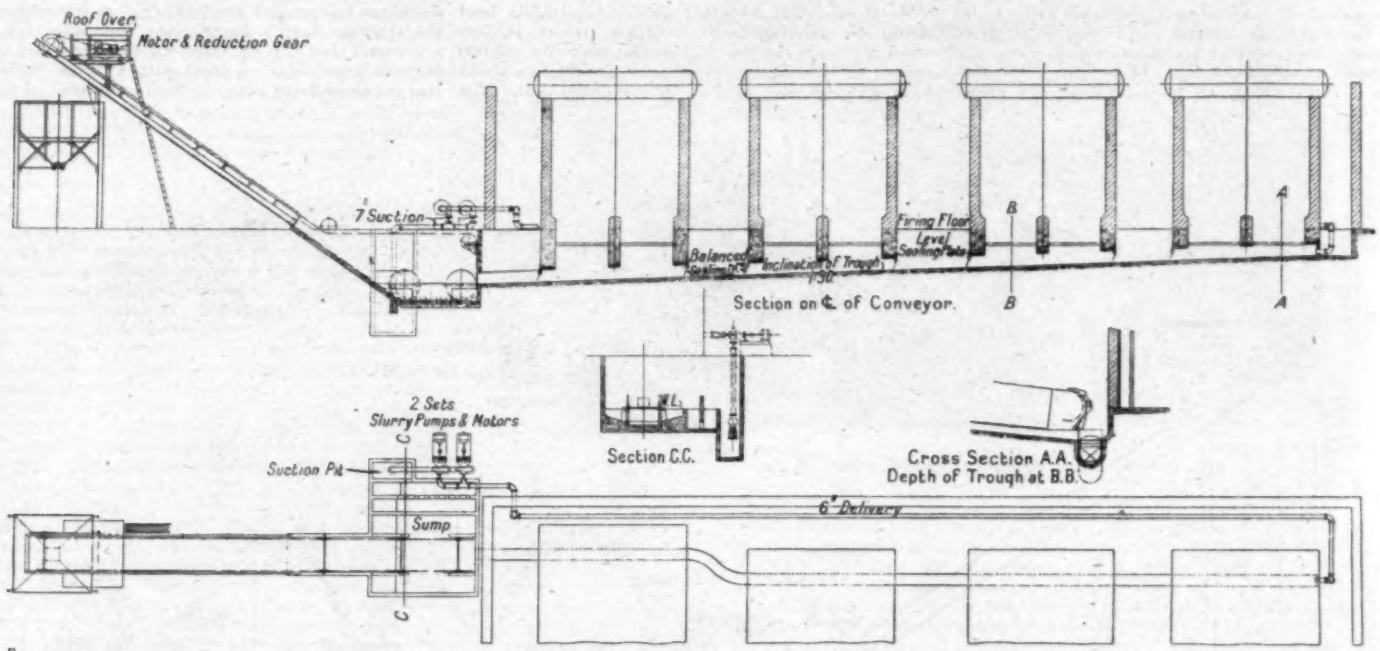


FIG. 84—PLANT FOR REMOVING ASHES BY MEANS OF FLOWING WATER

The Newcomen Society.

THE LIVERPOOL AND MANCHESTER RAILWAY.

On Wednesday evening, November 16th, Mr. C. F. Dendy Marshall presented, at a meeting of the Newcomen Society in Caxton Hall, a paper on "The Liverpool and Manchester Railway," of which we give an abstract below. A very interesting feature of the lecture was the exhibition of numerous drawings and contemporary prints of the railway and pieces of contemporary china, medals, &c., which Mr. Marshall had brought from his private collection. The paper contains a full catalogue of all these articles, and will, we understand, be printed in the "Memoirs" of the Society.

THE RAILWAY.

In 1797 William Jessop suggested that a tramroad, to be worked by horses, should be laid down between Liverpool and Manchester, and he surveyed a route. The following year Benjamin Outram made another survey for the line, but nothing came of either proposal.

The credit for the earliest practical scheme is due to William James, who drew up a plan in 1821, based on a preliminary survey, for a "Line of Engine Railroad from Liverpool to Manchester," in which he succeeded in interesting Joseph Sandars, a Liverpool merchant, who became one of the most active promoters of the line.

The first survey, in which Vignoles took part, was very imperfect, and a second one was made in 1822, with the assistance of Robert Stephenson. Soon afterwards, owing to ill-health and financial embarrassments, James became incapable of proceeding further with the matter, and it was put in the hands of George Stephenson. In 1825 an application was made for an Act of Parliament, which was unsuccessful. The

directors then appointed George and John Rennie as engineers, and employed Vignoles to prepare fresh plans, which resulted in the Act being obtained in 1826. They wished to make George Stephenson chief engineer, under the superintendence of the Rennies. As the latter objected to this arrangement their services were dispensed with, and Stephenson was given sole charge. The autobiography of Sir John Rennie contains the interesting statement that if they had remained in command the gauge would have been 5ft. 6in.

The question of motive power remained unsettled until October, 1829, when the success of the Rocket at Rainhill swept away all doubts on the subject. The opening ceremony took place on September 15th, 1830, being marred, as is well known, by the fatal accident to Mr. Huskisson. It is rather fortunate that there was no further mishap, as the victim was taken to Eccles by the Northumbrian at 36 miles an hour, and the Duke of Wellington's carriage, being left without an engine, was towed the rest of the way to Manchester by a train running on the other line. This carriage, which conveyed the principal guests, ran on eight wheels, and was a wonderful affair, 32ft. long, with a canopy supported on gilt pillars, more like a triumphal car than a railway vehicle.

The length of the line was 31 miles, double throughout. The cost was about £800,000, of which the principal amounts in round figures were :—Bridges, £100,000 ; cuttings and embankments, £200,000 ; land, £100,000 ; parliamentary and law expenses, £28,000.

In 1845 the company joined with the Grand Junction, and in 1846 the combined system was amalgamated with the London and Birmingham under the name of London and North-Western. A new chapter in the history of the communication between the two cities appears to have just been opened—1921—by an application by local authorities to the Lancashire County Authority to consider the construction of a motor road between them.

The Locomotives.

The first eight engines were similar in design to the Rocket in its original form, except that the cylinders were nearly horizontal. All had detached fire-boxes and truck and barrel tenders, except the last, the Northumbrian, which was the first to have a fire-box integral with the boiler barrel, a buffer beam in front, and a respectable-looking tender. It is probable she was also the first to have a smoke-box. As originally made this box appears to have been square in cross section ; it is drawn thus on a jug showing the opening procession. No other representations in perspective of the engine in this state are known, but the shadow indicated in a sketch in the *Mechanics' Magazine* for October 16th, 1830, corroborates the evidence of the jug. In an etching by Shaw of 1831 the smoke-box is normal.

The ninth engine was the Planet, which was a great step in advance. She has been illustrated in more than one book on the locomotive with the frame passing under the driving axle, a libel that is based on an old official drawing which has unfortunately survived, and evidently represents a design either never put into execution or abandoned before completion.

In 1831 a new type appeared, with the wheels coupled.

No. 28, the Caledonian, by Galloway and Co., had vertical cylinders working upwards, with return connecting-rods actuating a dummy shaft centrally disposed between the two axles, to which it was coupled. This is the form, anticipating Crampton, in which it is shown in a contemporary lithograph, and is therefore more likely to be correct than some more modern illustrations in which the cylinders are ahead of the smoke-box. No. 32, Experiment, by Sharp, Roberts, also had vertical cylinders, but over the leading wheels, operating the rear wheels by means of bell cranks. Though alterations were made, it proved a failure.

In the next engine, Patentee, we have the prototype of a favourite form of express engine for half a century. It was produced by lengthening the Planet design and adding a pair of trailing wheels, and was highly successful. The feature of the patent was the omission of flanges on the driving wheels.

No. 36, Swiftsure, by Forrester and Co., was originally a four-wheeled engine with outside frames and outside horizontal cylinders. She was the first engine with cylinders in this position, and the first to possess four excentrics. Drawings have frequently been given of her with six wheels, but the trailers were a subsequent addition. In 1836 and 1837 an extraordinary fashion for short stroke—only 12in.—set in, but was not continued.

One or two interesting engines were built for the line, but not taken over. Messrs. Braithwaite and Ericsson constructed a pair of enlarged editions of the Novelty, named William IV. and Queen Adelaide, which were unsuccessful. Another remarkable engine which ran on the line for a time in the early days was the Liverpool, by Bury, which had coupled wheels, it is usually said of 6ft. diameter, though this is doubtful. Later on, in 1832, one of Bury's engines, the Liver, No. 26, was purchased. It had single driving wheels.

Views of the Railway.

The interest aroused by the railway led to the production of a number of illustrations. The most beautiful series was that published by Ackermann, of fourteen hand-coloured aquatints. They exist in many different states, having been re-touched from time to time, alterations to the buildings, &c., being worked in. The first seven were also issued in a Spanish edition, with titles in that language, the English titles being cleaned off for the purpose, and replaced afterwards, naturally showing small differences. The latest impressions of all, dated 1833, are very inferior. Another set of illustrations of less beauty, but fully equal in interest, are eight etchings executed and published by Shaw, of Liverpool. Others were lithographed by Crane, of Chester.

Four medals were struck to commemorate the opening of the line, and three others for that of the Grand Junction Railway, which also refer to the Liverpool and Manchester.

Various articles in pottery, namely, jugs, mugs and plates, exist with representations of the trains, &c.

Bibliography.

A few of the most important items in the bibliography which accompanied the paper are as follows :—

1824. Letter on the Projected Railroad between Liverpool and Manchester. By Joseph Sandars.

1825. Report on Railroads and Locomotive Engines. By Charles Sylvester.

1829. Report to the Directors of the L. and M.R. on the Comparative Merits of Locomotive and Fixed Engines. By James Walker.

1830. Observations on the Comparative Merits of Locomotives and Fixed Engines. By Robert Stephenson and James Locke.

1830. An Account of the L. and M.R. By Henry Booth.

1831. An Accurate Description, &c. By James Scott Walker.

1831. Description and Historical Account of the L. and M.R. By Joseph Kirwan.

1833. The Railway Companion, describing an excursion along the Liverpool line. With ten lithographs. By a Tourist.

1836. A Practical Treatise on Locomotive Engines. By the Chev. F. M. G. de Pambour.

The line is, of course, dealt with at considerable length by many later and more general works. The fullest account of the preliminary proceedings and the actual construction is given by Smiles in his "Life of George Stephenson," though in order to obtain an impartial view it is necessary to consult a number of other books which are not so well known, as Smiles does not do justice to the part that James and Vignoles took in the undertaking.

Obituary.

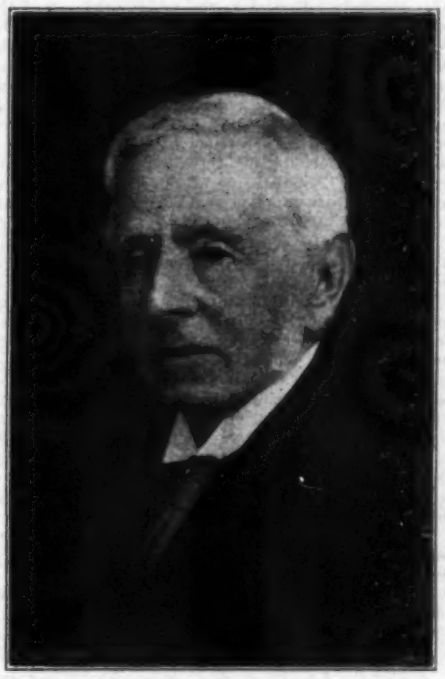
SIR DOUGLAS FOX.

We much regret to have to announce the death of Sir Charles Douglas Fox, which occurred in London on Sunday last after only a few hours' illness. As short a time ago as the first of this month, Sir Douglas was not only present at the Institution of Civil Engineers when the new President, Mr. Worthington, delivered his address, but, as Senior Past-president, proposed the customary vote of thanks. At that time there were certainly no signs that death was so soon to claim him. Yet he had reached an advanced age, having been born as long ago as the year 1840, his birthplace being "Bellefield," near Birmingham.

Sir Douglas was the son of the late Sir Charles Fox, himself an engineer of considerable distinction, who, among other numerous works, was responsible for the construction, to the designs of Sir Joseph Paxton, of the Crystal Palace, which housed in Hyde Park the Great Exhibition of 1851 before it was moved to its present site on Sydenham Hill. The erection of the huge glass building was a source of very great delight to Douglas Fox as a boy. Sir Charles also assisted the Swedish engineer, John Ericsson, when the latter, in partnership with John Braithwaite, was constructing the locomotive Novelty, which was beaten by Stephenson's famous Rocket in the historic trials at Rainhill in 1829. Sir Charles also acted under Robert Stephenson as one of the engineers who constructed the London and Birmingham Railway, which is now, of course, merged in the system of the London and North-Western Railway. It is not to be wondered at, then, that his son Charles Douglas should have adopted the engineering profession, nor that he should have devoted the larger portion of his long professional career to railway engineering.

Douglas Fox, after obtaining his early education at Cholmondeley School, Highgate, and King's College, London—of which he, later, became Fellow—was, in the year 1857 and when he was only seventeen years of age, articled to his father. It had been intended that he should go to Trinity College, Cambridge, but a serious accident which occurred to his father caused the abandonment of that idea. Young men began their serious life work early in those days, and frequently held positions of considerable responsibility at an age when our students of to-day are still at school. It was so with young Douglas, for when he was barely out of his teens he was made resident engineer in charge of the Witney Railway, a post which he held for two years till 1862, when the line was completed, and he was made engineer to the company which owned it. A year later, when he was twenty-three, his father took him into partnership, the same year, 1863, being marked by his marriage to Miss Mary Wright, daughter of the late Mr. Francis Wright, of Osmaston Manor, Derby. The work on which he was engaged during the early years of the partnership had mainly to do with railways in the South of England, including the Brighton, Chatham and Dover, and South-Western, though he was also concerned with the Queensland Government lines. Actually the first work which he did after entering his father's office was to assist the latter with the Cape Town and Wellington and the Cape Town and Wynberg railways, the forerunners of the now great system of South African railways. In 1857, too, he accompanied his father on his first journey to America. A year later he visited California with General Fremont, and while there he rode alone through thet Yosemite Valley and sent a most interesting account to *The Times*, he being among the first travellers, if not actually the first, who did so.

When Sir Charles Fox died, his two sons, Charles Douglas and Francis, carried on the business of consulting engineers, at first in Westminster and afterwards in the City of London, the title of the firm—which now includes, in addition, Mr. Ralph Freeman and Sir Douglas' son, Mr. Bertram Douglas Fox—becoming Sir Douglas Fox and Partners. The work with which Sir Douglas' name was more especially identified was considerable and varied. He, with the late Sir James Mirrlees, was engineer for the



SIR DOUGLAS FOX

Mersey Railway and the tunnel under the river between Liverpool and Birkenhead, which was opened for traffic by the late King Edward, when Prince of Wales, in the year 1886, and for his connection with which he received the honour of knighthood at the time. Together with the late Sir James Greathead, Sir Douglas constructed the Liverpool Overhead Railway. The bringing of the Manchester, Sheffield and Lincolnshire Railway—now, of course, the Great Central—into London at Marylebone, was another great piece of engineering in which he materially assisted, being in charge of the portion of the line which reached the Metropolis. He was also engaged in the construction of two of London's Tube Railways, the Hampstead and Highgate, and the Great Northern and City, which connects Finsbury Park with Moorgate-street, and which consists of two cast iron lined tunnels of sufficiently large diameter to accommodate the ordinary rolling stock of the Great Northern Railway. Perhaps his greatest work abroad was the fine railway bridge which spans the river Zambesi near the Victoria Falls, but he did a great deal besides. For instance, he was joint consulting engineer, with Sir George Bruce, for the construction of the South Indian Railway, and with Sir Charles Metcalfe was engineer for the Mashonaland and Rhodesian Railways, as well as for the Borneo Railway. He was, too, the first consulting engineer appointed by the Cape Government Railways, and under his guidance several thousand miles of lines were constructed. Among other South African lines with which he was specially concerned may be mentioned the Beira Railway, which involved the construction of harbour works, and the Benguela Railway. In South America he was responsible for the construction of railways in the Argentine, for the Central Argentine Railway Company ; in Colombia, for the Dorada Railway

Company; and in Brazil. Among other positions which he held at home was that of consulting engineer to the River Humber Conservancy, and his advice was frequently sought in connection with engineering works in tidal estuaries and rivers.

During recent years Sir Douglas had devoted much of his time and energy to the preparation of designs and estimates for the proposed Channel Tunnel, of the construction of the British half of which, it is understood, he and his firm were to have charge, if and when the project obtained sanction.

Sir Douglas was elected member of the Institution of Civil Engineers in 1866, was given a seat on the Council in 1884, and served as President in the session of 1899–1900. In his opening address he gave a survey of contemporary engineering, in which he ably discussed matters as widely separated as railways and shipbuilding, electricity and water supply, mining and motor cars. He endorsed opinions previously put forward by the late Sir John Wolfe Barry as to the relief of congestion in our streets, but suggested that perhaps an even better result could be attained by making short connections between back streets, so as to convert them into thoroughfares. It appeared to him, he said, equally important to remove the injurious mud and dust from the streets and smoke from the atmosphere, which seriously affected the welfare of the inhabitants. "May we not," he said, "look forward to a time when horses shall have given way, at least in towns, to mechanical traction, avoiding offensive smell, reducing noise and wear and tear, and enabling asphalt pavement to be used throughout with cleanliness and safety; when the cooking and heating of the town shall be effected, if not electrically, at least from gasworks situated in the neighbourhood of the collieries, and ceasing to add, as at present, their by no means unimportant quota to the volume of smoke loading the atmosphere; when the fog-producing marshes of the East shall be thoroughly drained and dried up; and when an efficient ventilation of sewers shall prevent the escape into the thoroughfares, especially in the higher parts of towns, of the foul gaseous emanations of the mighty sewage flow beneath?" Though some of Sir Douglas' prognostications have become verities, we fear that we are still a long way from the Utopian condition which he envisaged. In connection with his work for the Institution, Sir Douglas took a great deal of interest in standardisation. He was among those who were instrumental in bringing into being the British Engineering Standards Committee—now the British Engineering Standards Association. He had represented the Institution on the main Committee of that body from its creation in 1901 till March of last year. Although greatly in favour of the general policy of the Association, he was of opinion, and expressed himself to that effect in public, that care must be taken not to stereotype the details of design so thoroughly as to throw difficulties in the way of improvements. The experience with the Atbara Bridge—when the contract went to America—showed, he once remarked, how important it was, when early delivery was a necessity, to be prepared with type designs based upon ordinary merchant sections of steel. That principle, he added, was already carried out by British engineers employed upon railway extension in the Colonies, in India and abroad, but it was hardly practicable in thickly settled countries in which local circumstances involved variation in almost every span. As an instance in point, he quoted the Liverpool Overhead Railway, in the construction of which, though every effort was made to duplicate as far as possible, yet, for some 600 spans over 1000 drawings were found to be necessary.

In addition to the Institution of Civil Engineers, Sir Douglas was a member of both the Institutions of Mechanical and Electrical Engineers. He was also an honorary member of both the American Societies of Civil and Mechanical Engineers. He was director of some ten companies, was vice-chairman of the South Indian Railway Company, and chairman of the Industrial Dwellings Company, and of the Northfleet Coal and Ballast Company. He was County Justice and one of the original nineteen aldermen for the County of Surrey, afterwards being also appointed County Justice for London.

As showing the manner of man Sir Douglas was, as well as his outlook on life in general and his profession in particular, we cannot, we think, do better, in conclusion, than to quote once more from his "Civils" presidential address. Right at the end he said: "Our aim as a profession must be to leave behind us works of efficiency and stability, combined with economy of first cost and maintenance, and at the same time structures which shall, as far as possible, conform to true æsthetic taste and feeling. I am one of those who believe that destiny, whether it be of a nation or of an individual, depends upon character. Most earnestly, then, must we strive to hand down from generation to generation the tradition that to be a civil engineer implies the possession of high qualities, not only of intellect, but of character and heart."

JOHN WALLACE.

The death is announced of Mr. John Wallace, joint editor of the *Indian Textile Journal*, as having taken place recently in Bombay. Mr. Wallace, who had been closely associated with the industries and handicrafts of Bombay for the past thirty years, was educated at King's College, London, and gained his mechanical training in three of the leading workshops in this country, also serving some time on the Great Northern Railway, Peterborough, and at the Phœnix Gasworks, London. Subsequently he went to Cairo as chief engineer of the Egyptian Railways, and there he took the opportunity of volunteering his services to Lord Charles Beresford during the Egyptian Expedition of 1882. On that occasion he was appointed Chief of the Fire Brigade during the burning of Alexandria, and his knowledge of local conditions and familiarity with fire appliances proved of the greatest value to the military authorities. For these and other active services he was rewarded by the British Admiralty with the Silver Medal and the Bronze Star of the Egyptian Expedition of 1882, and he also received the Mejidieh—Official Grade—from the Egyptian Government. When peace was made he was requisitioned by the civil authorities to report on the sanitary condition of Cairo, and in 1885 he submitted a scheme, in collaboration with Mr. I. E. Cornish, M. Inst. C.E., for the drainage of the city.

The following year Mr. Wallace went to India to practise as a consulting engineer, and was entrusted with the designing of the waterworks at Cawnpore and of mill buildings at Aurangabad, Gadag, Ahmedabad and Bombay. Settling down in Bombay, he associated himself with the late Dr. Thomas Blaney in criticising and lecturing on the sanitary condition of the town, its water supply and drainage, and during the editorship of Sir T. J. Bennett, Mr. Wallace contributed articles on the subject to the columns of the *Times of India*.

On the question of Indian labour and the qualifications and idiosyncrasies of the workmen, Mr. Wallace could speak and write with special authority and intimate practical knowledge, and his advice in these matters was often sought for by the Government and employers of labour in general. He designed and made many simple and cheap appliances for handicrafts suitable for the average Indian workman, and in that connection he rendered valuable services to the workshops of the School of Arts in Bombay, which he improved and remodelled considerably while serving as Acting Principal in place of Mr. Burns. Commenting on his life, the *Times of India*—from which the foregoing information is culled—remarks: "A well-read man with sound mechanical training and varied opportunities of observing and studying the industrial and technical wants of this country, Mr. Wallace contributed in no small measure towards the uplift and improvement of the Indian artisan and workman. His best work in this direction was necessarily done through the columns of the *Indian Textile Journal*, with which he had been associated as joint editor since 1893."

EDWARD WINDSOR RICHARDS.

Mr. Edward Windsor Richards, M. Inst. C.E., a past-president of the Institution of Mechanical Engineers and of the Iron and Steel Institute, died on Saturday, the 12th inst., at his home in Monmouthshire, Plas Llecha, Tredunnock, Caerlon. He was born at Dowlais in 1831, and until recently, and despite his advanced age of ninety, had been remarkably strong and well. His father was engineer and general manager of the Rhymney Works, but his death, in 1831, as the result of an accident, left his family in somewhat straitened circumstances, and Edward, after having been educated at Christ's Hospital, London, began his career early by becoming apprenticed as an engineer in the Rhymney shops. Subsequently he entered the drawing-office. In 1854 he became for a few years assistant engineer to his brother, Mr. Edwin Richards, at the Tredegar Works, and in 1857 was appointed assistant engineer at Blaina, a post he resigned to go to Ebbw Vale, where he gradually rose to be first works manager and later general manager. It was during this period that, in 1870, Mr. Richards put down the first steel works at Ebbw Vale. In 1876 he was appointed general manager to Bolckow, Vaughan and Co., Middlesbrough. Soon after he was commissioned to lay down steel works for the company, a task he accomplished with the greatest credit, the works being the largest of their kind that had hitherto been built in this country.

At the time when Mr. Richards became manager of Bolckow Vaughan's works the great future which was before the Cleveland district was unsuspected, and the Cleveland iron ore deposits, which contained phosphorus, were practically neglected, as the methods of the day were inadequate for their development. Thomas and Gilchrist were, however, already engaged upon their classical experiments and had already succeeded in solving the problem of the use of phosphoric pig iron in the manufacture of steel. The experiments at Dowlais were attentively followed by Mr. Richards, who, in association with the inventors of the now well-known basic process, and with the late Mr. E. P. Martin, followed every stage of the process, which in 1880 he introduced at the Middlesbrough works with great success. This outcome secured to the inventors what had up to then been lacking, the recognition of the immense industrial value of their discovery, and Thomas himself placed on record the fact that but for the frank, generous and unreserved co-operation of Mr. Richards, dephosphorisation might have failed to obtain the recognition and application it deserved.

Mr. Windsor Richards, in 1884, was awarded the Bessemer Medal of the Iron and Steel Institute, of which he was one of the founders, and of which, in 1893, he became president. The work at Bolckow Vaughan's having become somewhat too strenuous, Mr. Richards, in 1889, became general manager of the Low Moor Iron Company; but in 1898, on the death of his wife, he retired from active work and went to live at Plas Llecha. Mr. Richards, in 1901, became a director of Guest, Keen and Co., Dowlais. In 1902 he acted as High Sheriff of Monmouthshire. He served on the boards of numerous companies, including Bolckow, Vaughan and Co., for many years, and in the course of his career published numerous papers on technical subjects, notably on the wear of steel rails and on the basic process of steel manufacture. In 1896 he was elected president of the Institution of Mechanical Engineers.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE BOILER EXPLOSION AT BUXTON.

Sir,—The explosion of the boiler of a new London and North-Western locomotive engine at Buxton is such an extraordinary occurrence that it has attracted the puzzled attention of all locomotive engineers. Minor boiler explosions due to collapsed fire-boxes or tubes and shortage of water are comparatively common and well understood. But this?

I served my time at the Crewe works, and afterwards spent a memorable year as fireman on the goods expresses between Carlisle and Chalk Farm. The modern safety valve, derived from the Ramsbottom duplex safety-valve, which cannot be tampered with, cannot have been at fault. It is inconceivable that this should be so. It is equally inconceivable that the driver and fireman could have been at fault. To one who knows, like myself, that the eyes of both driver and fireman automatically seek the pressure gauge every few seconds during the whole length of a railway journey, both during the running and the stoppages, it is clear, that the gauge must have shown a normal pressure just before the explosion occurred. I am convinced that there was no defect either as regards safety valve or *personnel*.

What explanation remains? An examination of the photographs just published in the Press gives proof, in the complete destruction of the engine, of an explosion of extraordinary intensity, resembling what would be expected as the result of the explosion of a mighty charge of dynamite placed in the position occupied by the boiler. But it was not dynamite or any other high explosive. My belief is that this was one of the extraordinary rare cases of the spheroidal state of boiling water, in which condition shock or vibration can convert the whole mass of water instantly into its equivalent volume of steam. The pushing over of the starting lever would be sufficient to destroy the antecedent equilibrium of the spheroidal condition. The spheroidal condition would not be shown upon the steam gauge, which would stand at normal. It is obvious that no safety valve in the world could relieve the terrific pressure instantly generated in such a case.

My object in addressing this letter to you is to suggest that in the inquiry about to be held, this possible explanation should not be lost sight of. It appears to me to meet the published facts. It is the more necessary that inquiry should be made, as what has once happened can happen again if the conditions should be repeated. Scientists should be asked as to what is known of the spheroidal state of boiling water, as to how this condition could arise in a locomotive boiler, and as to any known preventative.

E. R. Calthrop, M. Inst. C.E., M.I. Mech. E.

London, E.C. 2, November 15th.

APPROXIMATE FORMULÆ FOR COMPRESSION SPACE.

Sir,—The simplest exact derivative of the relation $PV^{1.3} =$ constant appears to be—

$$\frac{S}{V} = \sqrt[1.3]{\frac{G}{14.7}} + 1 - 1$$

Where S = Volume swept.
G = Compression pressure (gauge).
V = Volume of compression space.

May I submit the following simple approximation as being of probable interest to your readers?

$\frac{S}{V} = 0.275 + 0.0365\,G$. For G = from 50 to 90.

$\frac{S}{V} = 0.770 + 0.0330\,G$. For G = from 90 to 150.

This range covers most requirements in gas and petrol engine practice. The error does not exceed 1½ per cent.

F. W. James.

Letchworth, Herts, November 14th.

CAST IRON RESEARCH.

The following problems were submitted by members of the British Cast Iron Research Association during the month of October and investigations are being made upon them by the Director of Research. Details of all the results will be forwarded to all members upon completion of each work.

No. 29.—Pyrometers for foundry work.
No. 30.—Dead soft grey iron of non-brittle character.
No. 31.—Facing sand mixtures for heavy semi-steel castings in green sand.
No. 32.—Cause of fracture in heavy grey iron castings.
No. 33.—Defects in malleable iron castings and their remedy.
No. 34.—Correct method of running and gating semi-steel castings of intricate design.
No. 35.—Difficulties in cupola practice when melting white iron and means for minimising the trouble.
No. 36.—Foundry floor sand composition for heavy iron casting work.
No. 37.—Sponginess in malleable castings.
No. 38.—Defects in heavy intricate engine castings.

Technical questions upon routine foundry work have also been sent in by members and fully answered by the Bureau of Information.

A Seven-Day Journal.

Lower Railway Rates.

All branches of industry, and particularly the heavy engineering trades, are interested in the conference arranged to take place to-day between railway companies and representatives of traders on the subject of a general reduction of railway rates. It is understood that the railway companies are disposed to meet the needs of industry in this connection. The concessions which have been given in lower rates for the transport of the raw materials of the iron-making industry, with the exception of coal, can only be regarded as a very small instalment of what is necessary to reduce the considerable percentage which transport charges bear to total production costs in the iron and steel trades. The need of lower rates for the carriage of coal is obvious, and although no definite decision has been reached, the Mining Association has received an assurance that railway managements are giving this subject their earnest consideration. The opinion of the iron and steel industry is that it will be necessary to abolish the flat rate on coal and to restrict the maximum increase by at least 50 per cent. The same principle should, it is thought, be adopted in the case of semi-finished and finished products. The iron and steel trades might then be able to quote prices which would attract buyers.

St. Paul's Bridge.

On Monday next the Bridge House Estates Committee of the City Corporation will have before it a scheme for a bridge over the Thames between Blackfriars and Southwark bridges, which will be known as the St. Paul's Bridge. The project for building yet another bridge over the river is by no means new, as it was considered by the Corporation as long since as the year 1853. Money was definitely raised for the purpose in 1912, but the war stopped all progress and the money has since been expended in the reconstruction of Southwark Bridge and in the purchase of property to open up the approaches of the new bridge. It is believed that if the financial problem can be overcome—the method suggested is a Corporation loan—the work may be put in hand without delay. The plans, which have been prepared by Mr. Charles Barry and Mr. Washington Brown, are for a structure of five arches over the river and the continuation of the bridge in the form of viaducts over Thames-street and Queen Victoria-street to the Cannon-street level. The bridge and its approaches would be nearly a mile in length, and would provide a much-needed new traffic artery.

First Motor Liner.

The opportunity of inspecting at Liverpool the Aba, the 8000-ton motor ship of the British and African Steam Navigation Company, was taken advantage of by a large number of guests. This vessel may be regarded as the pioneer motor liner; she is the first motor-driven vessel running in a regular passenger service in which accommodation for a large number of passengers has been provided. The propelling machinery, which has been installed by Messrs. Harland and Wolff, comprises two eight-cylinder four-cycle Diesel oil engines of the Burmeister and Wain type, designed to develop 6600 indicated horse-power. The engine-room auxiliaries and other machinery are electrically driven. Having regard to the fact that the vessel will be required to make regular long non-stop runs, the propelling machinery has been subjected to severe tests, with, it is stated, satisfactory results. The service record of the Aba will be awaited with interest by marine engineers and shipowners.

Railway Companies as Manufacturers.

A deputation of representatives of the locomotive and carriage and wagon building industries waited on Mr. Neal, the Parliamentary Secretary of the Ministry of Transport, a few days ago. The permission given to railway companies many years ago to establish workshops was associated with the restriction that these shops should only manufacture for the owning company. Under the Railways Act, however, railway companies enjoy the power of manufacturing for each others' requirements, at least within the various groups, and possibly for members of another group. As railway workshops are operated under quite different conditions from those of private firms, and have never been organised for competitive trading, those engaged in the private industry have asked for a definite promise that no contracts for home railway work shall be withheld from the independent British industry except from motives of national economy, and that private firms shall be given the same opportunities as in past years of tendering for such work. The criticism has been frequently made that owing to railway workshops being auxiliary enterprises of the main business of railway companies, the real cost of production in such establishments has never been disclosed, and has, it is suggested, never been ascertained on a basis which would compare with the accounts of outside firms. If, however, the statement which has been made on numerous occasions that outside firms can manufacture at a lower cost than railway workshops is based on actual facts, the somewhat indefinite assurance given by Mr. Neal that the allocation of railway orders would depend on prices at which the work can be done may satisfy private firms.

Retirement of Sir Alexander Butterworth.

The announcement that Sir A. K. Butterworth, who has been general manager of the North-Eastern Railway for the past fifteen years, will retire on December 31st next was not unexpected. He will be succeeded by Mr. R. L. Wedgwood, who at present occupies the post of deputy general manager, a position held by Sir Eric Geddes before he became a Government official. Mr. Wedgwood has spent his whole working life with the North-Eastern Railway and has filled various *rôles*, including that of chief goods manager and chief passenger manager. During the war period he acted as Director of Docks, a position for which his experience in connection with the dock interests of the North-Eastern Railway admirably fitted him. Sir Alexander Butterworth, who is a lawyer—he was the company's solicitor before he became general manager—will remain in the services of the company, presumably in a consultative capacity, perhaps for some little time to come, as it is desired to have the benefit of his advice and experience in the amalgamation scheme which will constitute the North-Eastern and East Scottish group of railways.

Trackless Trolley Tramways for London.

An experiment in railless electric traction is about to be made by the London County Council if parliamentary sanction can be obtained. The trackless trolley route would extend over a distance of eight miles between West Norwood *viâ* Sydenham and Catford to Lee Green, where it would link up with the track routes of the Council. This is regarded as a very important cross-town connection, and if powers are granted it will, of course, be the first scheme of the kind to be tried within the London area. The saving in capital cost by operating a service over a route of eight miles without rails may be gathered from the fact that the estimated cost of construction and equipment is only £148,670.

Telephony Developments.

Investigation is proceeding in connection with what is best described as the loud speaking telephone system, the object being to enable the utterances of public speakers to be transmitted and reproduced at many different points while preserving the original voice tones. In the system which has been developed by the American Telegraph and Telephone Company, two sets of equipment are employed. For transmission purposes an improved type of telephone circuit, which has been evolved after a good deal of experimental work, is used, and special types of projectors are employed. It is stated that in a demonstration made a few days ago in New York a speech delivered at Washington was so intensified by the new method of projection that it could be heard over a range of 1000ft.

Nobel Chemistry Prize.

The announcement that the Swedish Academy of Science has decided to award the Nobel Prize for Chemistry for 1920 to Professor Walter Nernst, the well-known German chemist, will have been read with mixed feelings. Science may be untrammelled by the artificial boundaries of nationality, and Professor Nernst has done notable work, the lamp which bears his name being largely used. It is not forgotten, however, that he was one of the German scientists whose signature was appended to the manifesto defending the violation of Belgian neutrality, and it has been asserted that he was among those responsible for the first use of poison gas in the Great War.

Extending Thames Embankments.

Proposals to extend the Thames Embankments have been put forward on many previous occasions, and it would appear that at last definite action is likely to be taken by the London County Council. In a report just presented by the Improvements Committee of the Council it is stated that the question of connecting the Embankment, which extends from Victoria Tower Gardens to Lambeth Bridge with the existing Embankment in Grosvenor-road has been under consideration. The estimated cost of the works is £180,000, but as some delay must take place owing to the need of obtaining parliamentary powers, it is assumed that when the time comes for the actual placing of the contract it may be possible to carry out the scheme for a less sum than that named. The Thames Conservancy are faced with a large financial outlay, estimated at over £2,000,000, for the maintenance of the towing paths of the river. It is not possible to find such a sum out of the revenue of the Conservancy, and it will be necessary to take up the question with local authorities.

Motorless Aeroplane Record Flight.

Interest in the motorless air machine has been stimulated by the arrival at Croydon Aerodrome of the Aachen glider, with which a flight extending over twenty minutes was made at a recent trial. The machine, which was launched from a hill 1000ft. high, is reported to have been manœuvred to an even higher level and to have made a landing at a point only 30ft. below the original height of 1000ft. The previous time record for flights in machines of this type was beaten by six minutes. It is understood that other types of German gliders are likely to be sent to England, and that a series of gliding tests will be carried out. Aviation optimists suggest that it might be possible to produce for sporting purposes an aeroplane designed on the lines of motorless gliders, but which, fitted with an engine of about 2½ horse-power, would be able to make comparatively long low-speed flights.

Richborough Train Ferry.

A good deal of discussion is taking place both in Paris and in English trading circles with regard to the establishment of regular train ferry services of fruit and vegetables between the south-west district of France and the London markets. The chief difficulty arises from the fact that English wagons have to be used throughout the journey, as French rolling stock cannot be accommodated on the English section of the route. It would be necessary to construct special wagon stock for the ferry services if they are to be maintained, and the question has arisen who is to provide the necessary capital. An alternative method would be to bring the wagon through to Richborough and distribute from thence by transference to motor lorries or British wagon stock.

Safety of St. Paul's Cathedral.

The work of making good the serious structural defects which, with the lapse of time, have developed in St. Paul's Cathedral has now reached a critical stage. It has therefore been decided to seek the best expert advice, and a new Commission, consisting mainly of engineers, has been appointed. Without making a serious attempt to forecast the verdict of the Commission, Canon Alexander, the Cathedral Treasurer, believes that it may be favourable as regards the foundations of the edifice, of which a detailed examination has been made quite recently, but less optimistic as regards the superstructure.

Water-tube Boilers of Merchant Ships.

It is understood that the British Marine Engineering Design and Construction Committee, of which Mr. A. E. Seaton is chairman, has now prepared rules and regulations governing the installation of water-tube boilers in merchant vessels, which will be published at an early date. They have, it is reported, obtained the approval of the classification societies, and will therefore become standard practice. The Committee has now completed the special tasks assigned to it, but it has done such useful work that it is hoped it may not be disbanded. There are other directions in which the unification of the rules might with advantage be brought about.

The Newcomen Society.

The meeting of the Newcomen Society at Caxton Hall on Wednesday last was of exceptional interest, because Mr. Dendy Marshall, the author of a paper on the Manchester and Liverpool Railway, of which we give a *précis* elsewhere in this issue, had brought from his admirable private collection a large number of contemporary drawings and coloured engravings, as well as several jugs, mugs and plates decorated with illustrations of early locomotives and features of interest on the line. After he had presented his paper the formal meeting was broken up for a short time to allow the members to examine and chat about the exhibits, and subsequently a brief discussion took place. Altogether it was one of the most successful evenings the Society has held. It is pleasant to be able to record that this Society—the only one in the world, we believe, that is devoted to the study of the history of technology—has made such progress in its year of existence that a set of rules for its future management has been drawn up. We are glad to observe that they are flexible enough to admit of the free development of the Society in whatever way the future may show to be best.

Motor Car Exhibition at Olympia and the White City.

No. III.*

THE 10 horse-power car built by the Birmingham Small Arms Company, to which we referred in our last issue, is a distinct departure as regards its mechanical features from this firm's standard practice. It also possesses originality as regards the design of the body. The great objection to the ordinary dickey seat—that in bad weather its unfortunate occupants are left exposed—has been overcome in this case by a hood of ingenious design which can be extended to cover the dickey seat when necessary. When the dickey seat is unoccupied, the hood is of the ordinary two seater form, and with the side curtains provides complete protection from the weather. Should the dickey seat be occupied, however, the extension of the hood is only the work of a few minutes. There is also a fair amount of space for luggage in the tail even when the dickey is occupied, while with the dickey seat unoccupied, the luggage space is very considerable, as, in addition to space inside the tail, the flat sloping top is covered with ribbed aluminium and is adapted for use as a luggage grid on which quite large articles can be carried. With regard to the motive mechanism, there is nothing in the outer appearance of the car to give any suggestion that the mechanism differs from that of an ordinary car. The engine is placed under the usual bonnet, and not even the cylinder heads are exposed. The whole of the air for cooling purposes is taken in through the dummy radiator, and passes out partly through louvres in the bonnet sides and partly under the floor boards. The engine is of the twin V pattern, with cylinders 89.75 mm. bore by 85 mm. stroke. Sectional views of the engine are given in Figs. 14 and 15. The cylinders are of cast iron in one piece with the heads. There is a patented valve gear, whereby the radially inclined valves, which seat directly in the spherical head of the cylinder, are operated by rods lying parallel to the axis of the cylinder. The valves themselves are made of a new alloy produced by Wm. Jessop and Sons, Limited, and are tulip-shaped. The cylinder walls and head are thick to provide ample conductivity, and thus prevent distortion due to unequal heat conditions. The cooling fins are deep with roots of reasonable thickness, while the fins on the cylinder heads are so disposed as to equalise the temperature all over, and so prevent excessive temperatures in the neighbourhood of the exhaust valve seat and pocket. It is claimed that the inclination of the valves makes the combustion space of almost ideal form, so that the flow of heat to the walls from the burning gases is as small as possible, while the turbulence of the charge is kept at the maximum. The aluminium alloy pistons are full-skirted, as opposed to the "Slipper" type, so as to provide good dissipation of heat to the walls of the cylinder. By the insertion of a small spring ring at each end, the hollow floating gudgeon pins are prevented from moving axially and so scoring the cylinder walls. Both big ends, of course, work on a common crank pin, each big end being provided with a large diameter roller bearing. The crank shaft has balance weights, and is carried by two ball bearings which are seated in cast iron housings and not direct in the crank case, so that they cannot become loose in the aluminium.

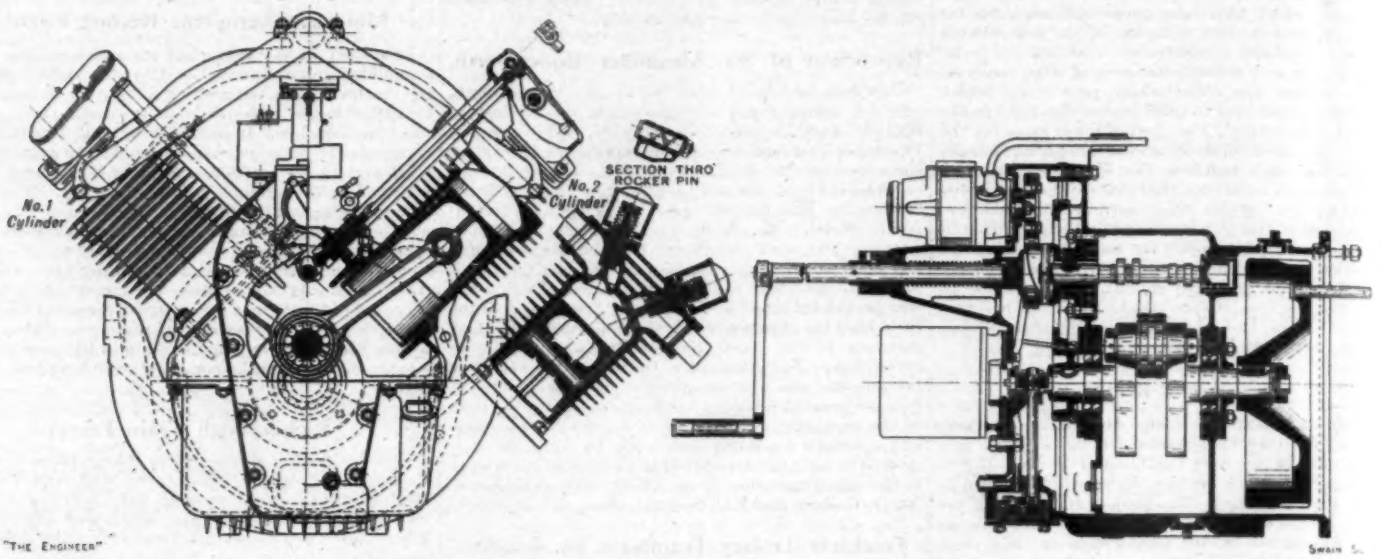
At the rear end the crank shaft carries the fly-wheel in the usual way, while adjacent to the front bearing is the spur pinion, which drives the half-time wheel on the cam shaft. The latter is mounted directly above the crank shaft, the cams themselves being inside the crank case, in the angle between the two cylinders. The four cams work direct on the mushroom-ended tappets, which are prevented from rotating and the tappets in turn operate the overhead valve rockers through the medium of long ball-ended push rods. Each overhead rocker is completely enclosed, and the push rods are also enclosed by telescopic tubes. The whole of the overhead valve gear is thus protected from dirt, and is lubricated automatically by oil mist sprayed up from the crank case through special grooves cut for the purpose in the tappet guides. Tappet adjustment is provided on the overhead rockers, and is immediately accessible by removing the rocker case lids. The M.L. magneto is gear driven off the half-time wheel on the cam shaft, and is provided with a micrometer adjustment for setting the ignition timing. The magneto contact breaker faces forward, and is thus very accessible. An oil sump holding sufficient oil for well over 200 miles' running is cast in one with the crank case. Oil is drawn from this through a large filter by a submerged gear pump driven by the crank shaft through spiral gears and a short vertical shaft. From the pump oil is forced under pressure up a pipe leading to the wall of the near-side cylinder, while small branch pipes cause jets of oil to impinge on the timing gears and the magneto drive gears. An oil spray is thus formed which effectually lubricates all bearings in the timing case. The off-side cylinder and piston are lubricated in the usual way by splash from the rotating crank shaft and big ends. Surplus oil from the crank case drains back to the sump, while the sump itself is finned to ensure that the oil is kept at the correct temperature. An oil flow indicator is fitted in a convenient place to show whether or not the lubrication system is acting correctly when the engine is running.

The starting handle is carried in an extension of the aluminium casting which forms the timing case cover, and engages with a dog on the end of the cam shaft instead of the crank shaft. Thus the engine is geared up from the starting handle, a feature which makes it easy to "swing" the engine at a good speed without undue effort. There is a special induction system, combined with the exhaust arrangements, which calls for attention. In this system a "hot spot" is provided adjacent to the Zenith carburetter, which ensures vaporisation of the lowest grade fuels.

From the engine the power is transmitted through a double plate clutch of the cork insert type to a three-speed and reverse gear-box of conventional design—see Fig. 16. This gear-box is bolted to the crank case, so as to form one unit with the engine. The clutch is completely enclosed in the fly-wheel pit between the engine and gear-box, but can be got at if necessary through an inspection door. The gear change is operated by a centrally placed lever, mounted on a ball and socket joint in the gear-box lid itself. It should be noted, however, that contrary to usual practice, when a central gear change is employed, the hand brake lever is not placed in the centre of the car, but is at the right-hand side of the driver, where it does not obstruct the seats, and cannot be interfered with by the passenger.

From the gear-box the drive is taken to the rear axle—Fig. D—by a tubular propeller shaft, which is completely enclosed in a spherical-headed torque tube. Inside the spherical joint and completely enclosed by it, is a ring universal joint, which is automatically lubricated from the gear-box. This is the only universal joint on the car.

The rear axle of the B.S.A. car is of the built-up type, with a cast aluminium centre and steel axle tubes. It incorporates a Daimler-Lanchester worm gear, which is silent in action. Daimler-Lanchester worm gears have been a feature of Daimler and B.S.A. cars for many years, but this new B.S.A. car is the first light car in which such a rear axle specification has been included. A standard type of bevel differential gear is fitted, while both hand and foot brakes are of the internally expanding type, operating in drums of unusually large diameter on the rear



FIGS. 14 AND 15—SECTIONS THROUGH ENGINE OF B.S.A. 10-H.P. CAR

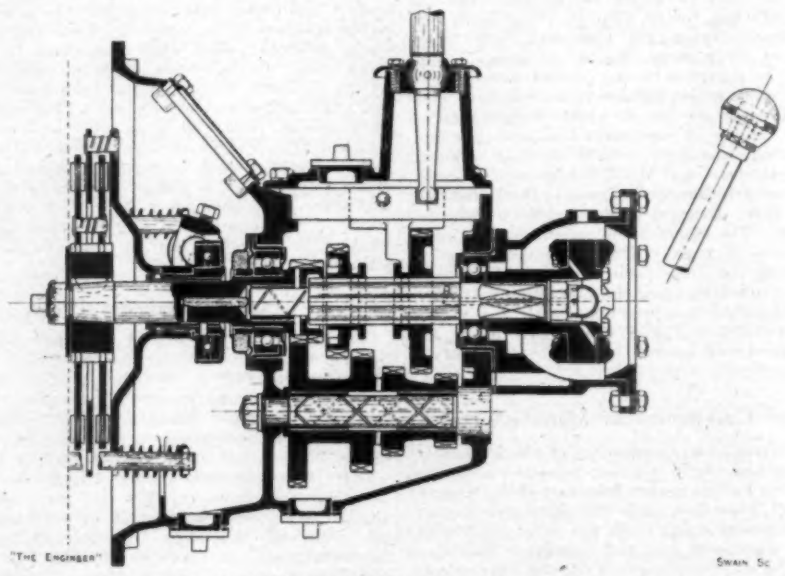


FIG. 16—GEAR BOX OF B.S.A. 10-H.P. CAR

* No. II. appeared Nov. 11th.

wheels. The brakes are of the non-compensated type, operated by rods throughout, and are provided with means for instant adjustment by spring-locked wing nuts, situated in an accessible position. Another interesting feature of the brakes is that if it be desired to inspect the brake shoes, it is only necessary to remove the detachable rear wheels, when the brake drums themselves can be pulled off by hand and the shoes with their operating mechanism exposed to view. This is an improvement on usual design, which necessitates the wheel centres being pulled off the axle shafts before the brakes can be exposed, a job

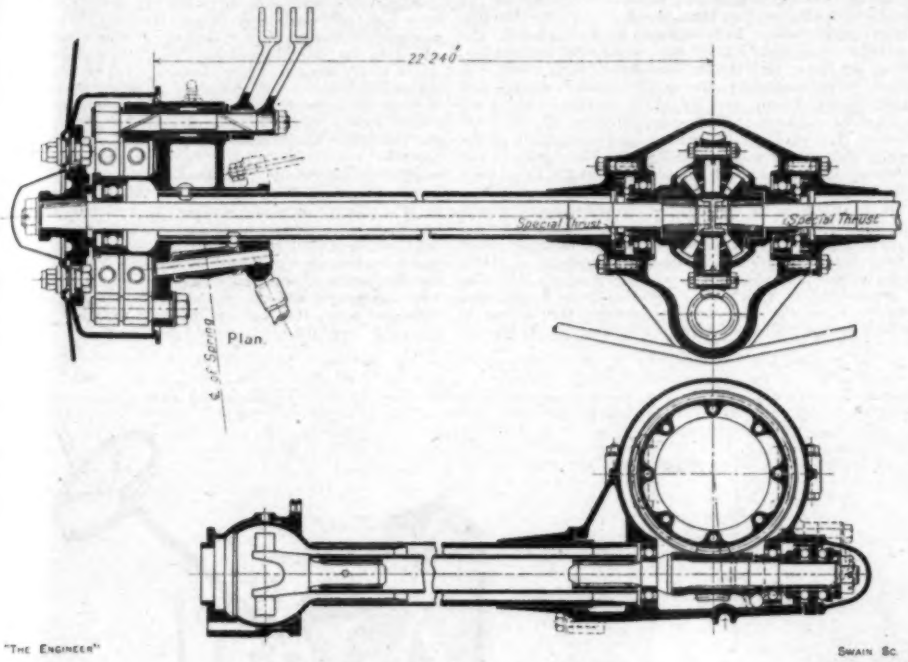


FIG. 17—REAR AXLE OF B.S.A. 10-H.P. CAR

which, as most owner-drivers know, often requires special tools not available in the owner's garage.

The front axle is of the usual I section forged type, but the stub axle and swivel pin design is unusual, in that it is so arranged as to allow the swivel pin to be in the plane of the wheel. Thus no bending moment is caused on the swivel pins by the weight of the car or by road shocks, and, moreover, there is no tendency whatever for the wheels to be deflected by road obstructions. This feature greatly reduces the stress on the steering gear, and makes it possible to drive the car with the lightest touch on the steering wheel, even on bad roads, and in spite of the fact that the steering gear is not irreversible. The steering gear, front hubs, spring shackles, brake rockers, &c., are fitted with Enots grease gun fittings. Quarter elliptical leaf springs are fitted front and rear. The foot accelerator pedal and ignition lever are on the steering column. An electric self-starter is fitted, and when the spark is fully retarded a special cam automatically opens the throttle to the correct starting position. The weight of the car complete is 12 cwt.

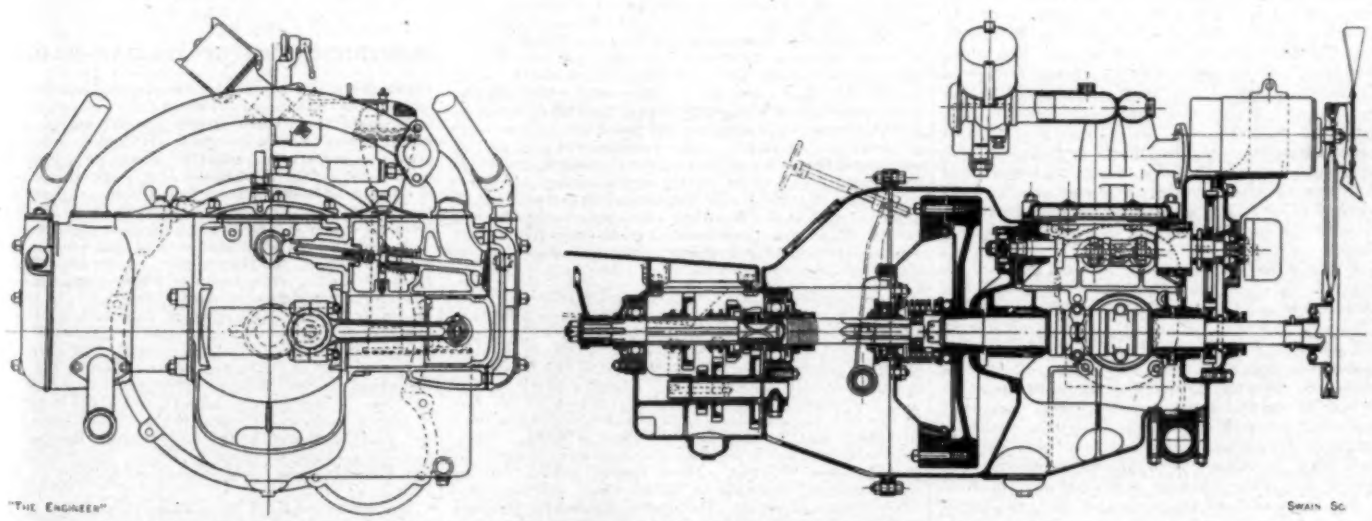
We referred last week to the chief features of the new light car which is being built for next season's market by the firm of Wolseley Motors, Limited, Birmingham, and we are now enabled to place before our readers sectional views of the engine and gear-box, Figs. 18 and 19. It will be seen that the engine is of the horizontal two-cylinder opposed type, water cooled, with thermo-syphon water circulation and automatic lubrication, and has cylinders 3½in. bore by 3½in. stroke, the Treasury rating being 8.5 horse-power. The fan and dynamo for lighting and ignition are driven by a belt from an extension of the crank shaft, and the cam shaft for operating the valves is driven by spur gearing from the crank shaft. The gear-box contains three forward speeds and a reverse, and the clutch is of the fabric-lined inverted-cone shape. The final transmission is by means of spiral bevel gearing. The normal speed of the engine is 1700 revolutions per minute, giving a road speed of 27 miles per hour, but the engine can be accelerated to 2500 revolutions per minute. The crank shaft is of the two-throw pattern, the main bearings being lubricated by pressure and the crank pins are fed centrifugally with oil collected by "banjo" collectors attached to the crank webs. The valves above the cylinders, as will be seen from the drawing, are operated through plungers from a solid cam shaft with sharp-nosed cams. The change-speed gears are operated by a selector gate on the off side, and a hand-starting gear is provided, which, by means of a wire rope, operates ratchet gearing on the clutch shaft. The weight of the car complete is 9¼ cwt.

Another small car to which attention should be called is the Stoneleigh, which is designed and built by Armstrong-Siddeley Motors, Limited, for Stoneleigh Motors, Limited. This car has a 90 deg. twin air-cooled engine, with cylinders 3.35in. diameter and 3.5in. stroke. It has overhead valves operated by tappet gear, and has a British high-tension magneto. The car is rated at 8.9 horse-power. Three speeds and a reverse are obtained through a central gear-box, and the final drive is by means of spiral bevel gearing. The clutch is of the single plate fabric covered type. A special feature of the car is the design of the body, which is built as a three seater, a single seat for the driver being placed in front of a double seat at the rear. The back seat is removable when desired to give ample space for luggage. The body is of polished aluminium.

A new application of the roller chain was shown in the Accessories Section by the Coventry Chain Company, Limited. It consists of a positive and flexible coupling, shown in Fig. 20. The unit comprises a standard duplex roller chain, provided with suitable coupling bolts at intervals, and two sprocket wheels, each having a boss on one side only, bored to suit the respective shaft diameters. Its design is such that a high factor of safety on the duplex chain is automatically obtained, owing to the stresses being divided equally over the teeth in the coupling flanges or chain sprockets. The coupling is not designed to replace universal joints where considerable angular motion has to be taken care of, but it can be fitted where the angular motion between the shafts does not exceed 2 deg. The coupling also permits of relative end movement between the two shafts, but this end movement should be limited to an amount equivalent to one-sixteenth of the shaft diameter.

FIG. 20—CHAIN FLEXIBLE COUPLING

Figs. 21 and 22 show two views of the Albert car chassis, which is being put on the market by the Service Motor Company, Limited, Great Portland-street, London, W. 1. This car has been before the public for two seasons, but has undergone certain improvements in details which are the result of road experience. The engine has four cylinders cast monobloc, with detachable cylinder heads and overhead valves. The bore and stroke are 68 mm. by 103 mm., and the Treasury rating is 11.9 horse-power. The crank shaft and cam shaft are made of a special high-grade steel, and the latter is driven by silent chains. The lubrication is automatic, being forced to the main bearings by a gear pump. The clutch is of the single plate type, and the gear-box has four forward speeds and a reverse. Externally, practically only one alteration from last year's car is visible, namely, the use of half-elliptic front springs instead of the previous inverted quarter elliptic type. At the rear the springs are half-elliptic cantilever, the free ends of the springs sliding on pads. The frame has been considerably strengthened in section, and has been lengthened 5in. in the rear, so as to avoid any overhanging of the body work. It has been made, furthermore, much more rigid against torsion by the fitting of improved cross members. In the engine only detailed alterations are found. The axis of the crank shaft has been inclined backwards, thus enabling the transmission to be kept in a straight line from the axle to fly-wheel, when the car is fully loaded. The exhaust outlet, instead of being cast integral with the

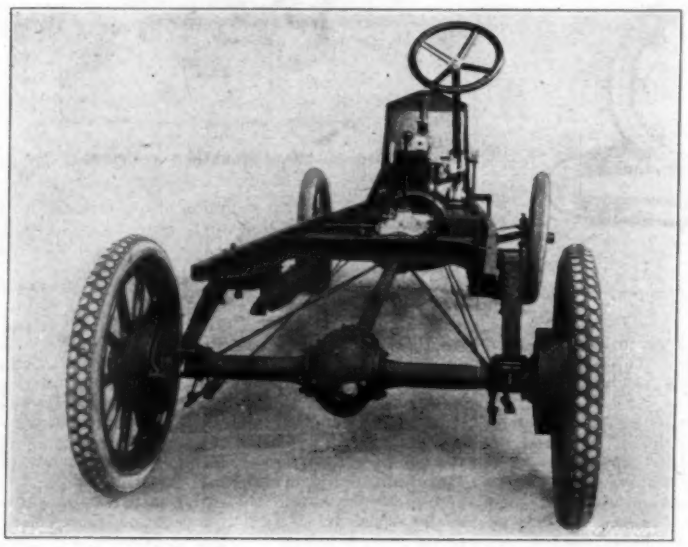


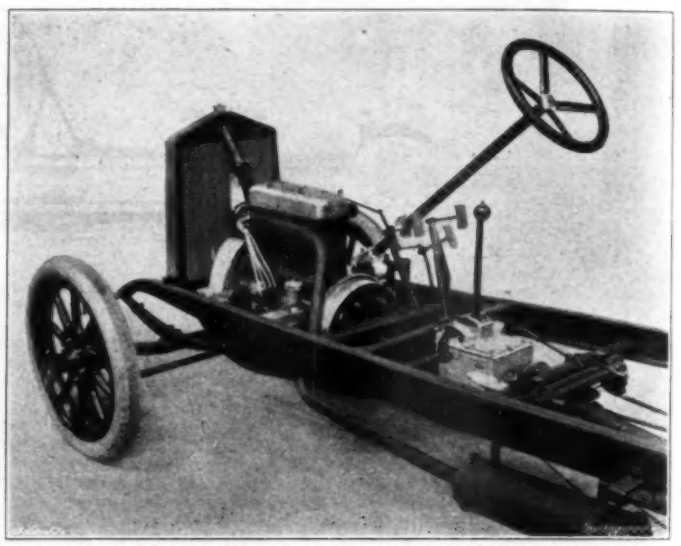
FIGS. 18 AND 19—ENGINE AND GEAR BOX FOR WOLSELEY LIGHT CAR

cylinders, is now detachable. In order to render the magneto more easily removable, a strap fitting has been adopted in place of the usual four studs in the base. The mounting of the engine in the frame has been improved by the insertion of aluminium fillets in the channel frame members at points which carry the crank chamber arms.

The clutch is lined with asbestos compound, which gives a very easy engagement. At the same time the clutch is light, so that gear changing at all speeds is rendered easy. The four-speed gear-box has been provided with an entirely new form of gate, and the change lever is altogether more robust and stronger. It is also placed so that no inconvenience is caused to the driver or passenger in changing gear.

The speedometer is furnished with a direct drive from the interior of the gear-box. Between the clutch and the gear-box two fabric disc type universal joints have been inserted. The brakes, all four of which operate on the rear wheel hub drums, are now fitted with cables in place of rods. Both sets are adjusted by a single turn buckle, acting between the lever or pedal on the compensating bars. Both these adjustments are immediately accessible by inserting a simple tommy bar, and no special tools are required for this purpose, the turn buckles having a broad eye, through which a screw driver, tire lever or other tool can be easily passed. The front wheel bearings have been increased in diameter, and the stub axle is of the swivel head type. Considerable improvements have been incorporated in the back axle





FIGS. 21 AND 22—CHASSIS OF THE ALBERT 11.9-H.P. CAR

design. Previously, an aluminium centre casting with pressed-in axle tubes was employed. This has been displaced by a steel centre casting carrying flanged steel tubes. The axle is furthermore of the full floating type. The C.A.V. dynamo and self-starting installation is of the latest type. The latter is controlled, not as previously by pedal, but by a simple button switch on the instrument board. The coachwork is on the same comfortable and pleasing lines as before, and an entirely new type of four-seater touring body has been introduced. Its principal features are that by means of an original arrangement of side curtains, the car can be converted from a fully open four-seater to the equivalent of an entirely enclosed saloon limousine in a few moments.

It is impossible in the space at our disposal to describe all the small cars that were on view. The Standard, Calcott, Calthorpe, Rover, Morris, Deemster, Singer, Hillman, Lagonda, A.B.C., and Jowett are all more or less standardised products. Small improvements here and there have been effected in most of these cars, the outcome of severe competitive tests, but the new 5 horse-power Citröen car, built by the well-known French firm, which has made a considerable reputation for its wonderful gear cutting, has not been previously seen in this country. The chassis of this little machine is a very neat production, with a miniature four-cylinder vertical engine rated at 7.5 horse-power, the cylinders being only 55 mm. diameter by 90 mm. stroke. The engine has thermo-syphonic water circulation, and is fitted with an electric starting motor. The gear-box has three forward speeds and a reverse, central change and the clutch is of the single dry plate type. The final transmission is by means of Citröen helical gearing. The car has a two-seater body.

Purchasers of the small two and three-seater cars had quite a number of makes to select from. There were seven or eight at prices under £200, and at prices between £200 and £300 probably twenty builders are now competing. Under the existing costs of production, it would seem unlikely that there will be any material reduction in prices of these small cars during the ensuing year. The tendency to provide a more comfortable and sweeter running machine than formerly means an increase in the cost of production, which for the present can only be counterbalanced by increased output.

Electrification on the L.B. and S.C.R

In this week's issue of *Modern Transport* there is an abstract of a report on the electrification of extensive portions of the London, Brighton and South Coast Railway. The report has been prepared for the company at the instance of the Ministry of Transport by Sir Philip Dawson, in close collaboration with Colonel L. B. Billinton, the locomotive engineer, Mr. Finlay Scott, the superintendent of the line, Mr. R. H. Houghton, B.Sc., electrical engineer to the company, Mr. A. H. Panter, carriage and wagon superintendent, and Mr. O. G. C. Drury, the company's chief engineer. The report refers to the electrification of the whole of the suburban system and subsequently the main lines to Brighton, Eastbourne, and Worthing. As a result of calculations which have been carefully worked out by the officers of the company, there would be, it seems, by a process of electrification a saving in operating expenses on existing traffic of from 6 to 7 per cent. on the capital involved in respect of those works without regard to the very large development of traffic which would undoubtedly result therefrom. Allowing for improvements which may reasonably be anticipated in traffic operations by electric haulage, the saving in numbers of electric locomotives is estimated at 53 electric to 98 steam, or no less than 46 per cent. The area of electrification covered by the present scheme includes the whole of the Brighton company's system in the London district north of Coulsdon and Epsom, and the main lines Coulsdon to Brighton running south, Keymer Junction and Brighton to Eastbourne running east, and Preston Park and Brighton to West Worthing running west. The economies to be effected by electrification are summarised as follows:—(*a*) Increased acceleration, which re-acts upon wages not only of engine crews, but also of shunters, by the time saved in shunting and marshalling operations; (*b*) stand-by losses are very considerably reduced, on account of the fact that there are no energy losses whilst the locomotive is not in motion or is coasting; (*c*) there are savings in time due to the elimination of running for water, as well as the fact that an electric locomotive can remain in service practically continuously for a very extended period, thus avoiding running to sheds for coal and other engine requirements.

Careful estimates have been prepared relative to the savings in working costs derivable from electrification. Minute calculations have shown that the cost per train mile on the London suburban passenger service is 50.517d. for steam locomotion as compared with 27.18d. for electric locomotion. On main line and country local services the corresponding figures are 41.769d. and 26.741d. In the case of local goods services the figure for steam is 107.083d., and for the electric system 64.084d.; whilst for main line goods services the respective figures are 66.054d. and 52.028d. These figures include running costs, repairs, renewals of locomotives, carriages and mechanical equipment. The figures utilised for the comparisons are based on the prices of labour, fuel and materials at the end of 1919 and do not include increases in the cost of wages and fuel which have become effective since that time. It is pointed out, however, that with regard to fuel, the higher the cost of coal the greater the proportion of saving effected by electrical operation, due to the fact that a more inferior quality of coal can be utilised for steam-raising purposes in stationary boilers of a power station than on a steam locomotive, and that the coal is more efficiently employed in the former than in the latter. As regards wages, a similar explanation applies, since the better schedule speeds result in more efficient employment of train crews and staff. There has always been a clear understanding among the officers of the company that in order properly to utilise the carrying capacity of the main line to Brighton it is essential to operate the service electrically. For this reason the single-phase system was adopted. Before the war contracts had been let for the electrification of practically all the company's suburban passenger services in the London area north of Coulsdon and Cheam, involving the equipment of 141 single-track miles in addition to the 70 single-track miles already equipped and in use. Up to the outbreak of war and during its earlier stages 42 single-track miles were equipped with overhead line, but on account of increasing difficulties in obtaining labour and materials and the impossibility of securing rolling stock and train equipments, the additional lines could not be completed and brought into use before the conditions rendered progress impossible without re-adjustment of the financial position. Schemes were also in active preparation before the war for the electrification of the main lines to Brighton, Eastbourne and Worthing.

As already indicated, there are two factors which enter into the anticipated financial results:—(*a*) Saving in working costs, and (*b*) increase in revenue apart from the necessity for providing the additional transport facilities which the present situation demands. It is clear from the arguments upon which the report is based that the actual savings in working costs would not be realised to their fullest extent until the steam services were eliminated. On the other hand, the profits derived from increase in revenue would, as proved by existing experience, be realised immediately. Concluding his report, Sir Philip Dawson says: "That the field for this increased revenue is, if anything, a more favourable one than that which has been already exploited, and that the portion of that field which would be covered by the completion of the electrification of the suburban services is more than ripe for development can hardly be doubted. When compared with the figures already quoted for the existing electrification and with the further increase in fares which has recently been made, it would not appear unreasonable to anticipate, despite the heavy capital cost, which is now inevitable, an additional profit which would give a return of 15 to 20 per cent. on the additional capital."

ELECTRIFICATION OF ITALIAN RAILWAYS.

The Italian Government is now engaged on a programme for the electrification of 4000 kiloms. of railway trunk lines, comprising some 10,000 kiloms. of track. The whole of the railway system in the highly industrialised provinces of Piedmont and Liguria will be electrified, and in this section the electrification of 1000 kiloms. of track is already an accomplished fact. Work is nearing completion on the Genoa–Pisa–Spezia–Leghorn and on the Bologna–Florence, and Bologna–Faenza lines.

An experiment with three-phase high-tension current will be made by the Government on the short line from Rome to Anzio, while the new Rome–Naples direct line will be inaugurated with electric traction. In the south of Italy the Benevento–Foggia line will be electrified experimentally on the direct-current system. On all the lines mentioned the work is already well advanced.

The next stage in the programme provides for the electrification of the Bologna–Verona–Brenner line, which will become increasingly important for the development of Italy's trade with Central Europe, the Voghera–Milan, the Voghera–Piacenza, the lines serving Trieste, Gorizia and Julian Venetia, down to Fiume, the Milan–Chiasso, the Milan–Bologna, and several other lines in Central Italy.

The power required for running these railways will be supplied mostly by the hydro-electric installations built by private corporations, in conjunction with some large central stations which the State railways are erecting, *e.g.*, that at Bardonecchia, which is now nearing completion, two others in Central Italy which will utilise the waters of the Reno and the Limentre now being rendered available by hydraulic works in course of execution, and a central station near Scanno in the Abruzzi, which will be fed by the waters of the Sagittario. In connection with this latter station, a barrage some 80ft. high, which will form an artificial lake with a capacity of 3,600,000 cubic feet, is being constructed. The water will run through a tunnel 6 kiloms. in length, passing through the mountains some 12,000ft. below their summits, and will fall some 350 m. through three high-pressure pipes, each 785 m. in length, and drive three groups of three-phase dynamos of a combined capacity of 45,000 horse-power. It is estimated that these works will be completed in 1924.

Railway Matters.

ALTHOUGH the cost of living fell from 120 points above July, 1914, to 110 points in October, and thus meant a reduction of 2s. per week in the railwaymen's wages, no change can be made until January.

IT is just twenty-five years ago since the Great Western Railway Centre of the St. John Ambulance was formed, with Princess Christian as the first and the present president. During these twenty-five years 15,000 first-aid certificates have been gained by Great Western men.

IN reply to a question, the President of the Board of Trade stated on the 7th instant that the selection of twenty-two representatives of trading interests whom he had to nominate to the general panel under Sec. 24 of the Railways Act was under consideration in consultation with bodies representative of the trading interests.

THE question of the Ministry of Transport becoming part of the Board of Trade again cropped up in Parliament on the 3rd instant, on which occasion Mr. Lloyd George said that it was a matter requiring very careful consideration. He was not sure that the Board of Trade would be the best department, and he was not prepared at the moment to express an opinion.

EARLY on Friday morning last the boiler of a London and North-Western goods engine burst at Buxton. The driver and fireman were killed, and there was considerable damage to property. The inquest on the two unfortunate enginemen was adjourned until to-day (Friday), when perhaps some light may be thrown on the cause. We hope to refer to the subject again later.

IN a paper on "Three-position Signalling," read before the Institution of Railway Signal Engineers on the 2nd instant, Mr. A. E. Tattersall pleaded for uniformity of aspects so that any one aspect should on all occasions mean the same thing. He submitted twenty-two suggested aspects, each of which told its own tale, and recommended that the Institution should consider each *seriatim*.

THE ventilating plant in the Severn Tunnel, after thirty-five years' service, is to be replaced by a larger installation so as to supply 800,000 cubic feet of air per minute. The fan, measuring 27ft. diameter and 9ft. wide, will be constructed of iron and steel and worked normally at a speed of 100 revolutions per minute. Messrs. Walker Bros., of Wigan, who fixed the present plant, have the new contract.

FOLLOWING on the 2s. 6d. lunch of a cut from the joint, two vegetables, and sweets or cheese of the Great Western, the London and North-Western and Midland have reduced the charges for their luncheons in the first-class car from 4s. 6d. to 3s. 6d., and in the third class from 4s. to 3s. 6d. On the Lancashire and Yorkshire the first-class luncheon will be reduced from 4s. to 3s. 6d. and the third class from 3s. 6d. to 3s.

CONSIDERABLE interest is being taken in Manchester in the possible amalgamation of the London and North-Western and the Lancashire and Yorkshire Companies, and its effect upon the adjoining Exchange Station of the former and the Victoria Station of the latter. The London and North-Western lines to and from Huddersfield, Leeds, &c., pass through Victoria, but there is no direct connection with the Lancashire and Yorkshire lines on the Salford or western side. The Midland Company runs into Victoria.

THE Argentine National Railroad Administration, we learn, is rapidly formulating definite plans to construct a thousand kilometres of narrow-gauge lines to link Patagonia with the markets and ports of Argentina. At the present time the inhabitants of Patagonia are forced to depend on irregular steamship service as the only means for the shipment of their wool and other products. Such conditions hold up the development of the huge extent of territory covered by the district. It is also stated that a million sleepers have been bought for the construction of the new railway, and that partial plans have been made for the financing of the scheme.

A CERTAIN railway in one of the Western States of America kept a record of the length of time its permanent way men remained in the service, and at the end of nine months some remarkable figures were revealed. Of extra gang labourers, 890 were given work, but only 311 reported for duty. Of these, 108 left in one to ten days, 78 in eleven to twenty days, 48 in twenty-one to thirty-one days, and 60 in one to two months. Of 401 section gang labourers, only 154 reported for work, and of these 137 had gone at varying intervals up to the end of two months. At the end of the nine-month period only 4 of the extra gang and 3 of the section gang had been in the service for over four months.

AT the sleeper-treating plant of the Atchison, Topeka and Santa Fé Railroad the trams that enter the creosoting cylinders carry forty-three 8ft. sleepers, 7in. by 8in. Thirty trams at a time are drawn by a locomotive crane from the cylinders to the storage stacks, a distance of half a mile, where the use of a double-chain sling enables the complete load of forty-three sleepers to be picked up at one time and placed on the pile. Were manual labour employed on this work the cost would be at least 2 dols. per hundred sleepers, whereas the present cost is 37 cents. Two men would be required to handle each sleeper, and they could not pile them higher than shoulder high, whereas the crane piles them to a height of 20ft.

IN the First Division of the Court of Session on the 9th instant the judgment of the Railway and Canal Commission in the North British Railway Company's claim for £435,000 was recalled. This judgment is not as antagonistic towards the railway company as may be supposed; it merely asserts that the Ministry of Transport had power to withhold the sum, and that this power was not used illegally, unreasonably or capriciously. No reflection was cast on the integrity of the railway company or its chief officers, nor was any pronouncement made as to the merits of the claim. In concluding his judgment—with which his colleagues agreed—the Lord President said: "It was a pity that the inconvenience which the railway company had suffered could not have been avoided by the Transport Minister's acceptance of some such accommodation as the Lord Advocate very properly proposed to give the company."

Notes and Memoranda.

IN the new gold test of the United States Bureau of Standards, electric sparks passed between two pieces of the metal are photographed through a diffraction grating. The spectroscopic lines appearing on the negative reveal impurities as small as 1 part in 100,000, and have proved that the finest grade of gold has a purity of only 99.97 per cent.

THE refractory silica brick industry in the United States continued to make progress in 1920. These bricks are used principally in by-product coke ovens, in open-hearth steel furnaces, in copper reverberatory furnaces, and in the glass industry, in which they must withstand high temperatures, such as would fuse ordinary clay fire-brick. They also withstand abrasion well. The output in 1920 was 255,000,000 bricks, valued at 15,540,000 dols, or 60.94 dols. a thousand, an increase of 18 per cent. in quantity and 32 per cent. in value as compared with 1919.

CONSIDERABLE attention is being paid in Germany to the process devised by the late Dr. Runkel, chemist to the Bayer Company, for the recovery of benzol from gas by absorption by wood charcoal. The progress has been long known in France, fand has been tried in the United States, where, since 1911, experimenters have tried to recover petrol from natural gas by these means; but it has not led to much, though the problem is in that case a relatively simple one. In 1916 the French Ministry of Munitions tried charcoal in order to recover ether-alcohol in explosives works; but it was found to be troublesome and expensive.

IN order to assist in the stimulation of British trade with France the British Chamber of Commerce in Paris is preparing a new and revised edition of its Franco-British Trade Index. The cost of compilation, classification, printing and distribution of the Trade Index amongst French buyers will be met from the funds of the Chamber, the only stipulation being that the firms appearing therein, under the various classified headings of their manufactures or exports, shall have shown their interest in British trade in France by becoming members of the Chamber. No subsidy is received by the Chamber from the Government, which entirely depends on the members' subscriptions to carry on its valuable work. The membership roll at present includes nearly 2000 British firms or subjects.

THE proper heat treatment of drop forging dies, states the *Drop Forger*, is perhaps one of the most important steps in the economical operation of a drop forging plant, for nearly all other economies may be nullified by improper heat treatment. On the one hand, careless handling in the heat treatment may spoil the dies and cause a waste not only of the material from which they are made, but of all the labour that has been put into the sinking of the impressions. On the other hand, even though the dies may pass from the hardening room in what may appear to be first-class condition, if they are not of the right hardness and toughness, they will not stand up under the hammers anywhere nearly as long as if correctly treated, and as a result the cost of dies will increase rapidly. Too much attention cannot be paid to the heat-treating department in any plant, and this is specially true in a drop-forging plant where dies are hardened and drawn.

CAREFULLY compiled statistics from various independent sources show that the probable oil resources of the world are not so limitless as was once surmised, although there is no disposition to view the future with that pessimism felt by some technologists. Oilfields, states Mr. A. Beeby Thompson, in a paper read before the Petroleum Technologists, do not cover vast areas like coal, but are represented by comparatively small and isolated pools where concentration has been induced by a combination of geological events. Existing as a liquid more or less volatile and usually accompanied by much gas, petroleum is frequently expelled with violence when its source is tapped by a bore-hole. The contained gas constitutes the agent of expulsion. It is this circumstance that enables gas and oil strata to be so quickly deprived of their flush contents instead of having to adopt laborious, lengthy, and costly mining operations as in the case of solid fuels.

REPLYING to the discussion of his paper on "Hydraulic Stowing," at a recent meeting of the South Wales Institute of Engineers, Professor G. Knox said that the amount of pressure they might get was determined by the distance they allowed the overlying weight to drop and the time in which they allowed it to drop. If they worked coal quickly and packed closely behind, the amount of drop was very little and they saved all that cracking of the roof, forcing off pieces into the working, which was commonly associated with any slow method of working coal seams. The better they packed, the further beyond the face did they force the line of fracture, if it fractured at all. Therefore the total amount of support required on the part of the gob next the face was reduced considerably. They could see on one side of a mine strips of hydraulic packing put in as far apart as the walls of a room and in the other side of the same pit, where they were still continuing the old system, supports put up as little as 2ft. to 3ft. 6in. apart, with falls of roof continually occurring.

TWIST drills, although correctly ground, are often observed to fracture at the edges. This trouble, according to the *Edgar Allen News*, may be taken as an indication of too heavy feed. The speed should be increased and the feed correspondingly reduced. If the extreme edges alone are affected, the speed is too high. If the edges of the cutting lips break down soon after the drill has begun its work of penetration, it is a sign that the angle of lip clearance is too great. The splitting of the drill from the point up the centre may indicate too small a clearance angle. Unequal grinding of the lips and unequal angles on the cutting edges are productive of many drill failures. Sometimes the hole is larger than the drill, pointing to faulty lip grinding. Sometimes the drill will not centre properly, showing that the angle of the cutting edges is too great. In both cases the strain on the drill and the machine that drives it is intense. Slower drilling and excessive driving power required to do the work are symptoms which, if neglected, lead ultimately to breakage and consequent loss.

Miscellanea.

IN January last the United States of America exported to Europe 534,736 tons of bituminous coal and 1170 tons of anthracite coal at an average cost f.o.b. of 8.81 dols. per ton. In June the quantities were 1,461,035 and 556 tons, and in July 1,011,548 and 2966 tons at an average cost of 6.57 dols. and 7.48 dols. respectively. In August, however, the quantities were only 143,159 and 40 tons at a cost of 6.44 dols. per ton.

IN the public park at Barrow-in-Furness on Armistice Day, Field-Marshal Sir William R. Robertson, unveiled a war memorial. It consisted of a limestone pillar, 36ft. high, and was the gift of the Barrow Hematite Steel Company, Limited. The memorial was dedicated by the Bishop of Carlisle, and handed over to the Mayor of Barrow by Mr. G. Mure Ritchie, the chairman of the Barrow Hematite Steel Company, Limited.

THREE new ferry steamers are being constructed at the Welsh Island yards, Sydney, for Sydney Ferries, Limited. The first of them, which was ready for launching in the beginning of October, will be employed for vehicular traffic. The remaining two vessels, which are capable of carrying 2350 passengers each, are also nearing completion. The contract price for the construction of the three steamers was in the vicinity of £200,000.

THE second annual Wireless Exhibition promoted by the Birmingham Experimental Wireless Club will be held at the Municipal Technical School from January 18th to 22nd next. Continuous demonstrations of the latest advances in wireless telegraphy and telephony will be arranged, and a unique display of both amateur and commercial apparatus has been promised. Popular lectures will be given each evening by wireless experts.

MEMBERS of the Institution of Gas Engineers are invited by the Chemical Engineering Group of the Society of Chemical Industry to attend a meeting of the Group, which is to be held in the Lecture Theatre of the Institution of Electrical Engineers, Victoria Embankment, at 8 p.m., on Tuesday, November 22nd, when a paper on "The Claude Synthetic Ammonia Process and Plant" is to be read by Mr. J. H. West, A.C.G.I., M. Inst. C.E.

THE Cristobal Colon, a vessel of 13,735 tons, is the first large mercantile boat constructed by the Ferrol naval yards. Her dimensions are:—Length 149.90 m., breadth 18.10 m., depth 13.60 m. The engines consist of two sets of turbines capable of developing a maximum of 10,300 horse-power, which will, it is calculated, enable the vessel to maintain a speed of 16½ knots. The keel was laid down in April, 1916, but little work could be done on the vessel during the war owing to the scanty quantities of material received.

IT is announced that having in view his long association with electrical progress in this country, and his great services to the Institution in connection with the obtaining of a Royal Charter and Royal patronage, when his enthusiastic help, by counsel, advice and active co-operation with the Charter Committee, proved invaluable, the Council of the Institution of Electrical Engineers has elected as an honorary member Lord Southborough, P.C., G.C.M.G., &c. Lord Southborough is perhaps better known to electrical men under his older title of Sir Francis Hopwood.

BRADFORD'S electricity undertaking has the distinction of being the first municipal undertaking to introduce and develop the system of letting electric motors and apparatus on hire. In consequence of the great increase in the prices of new motors and starters, the higher rate of interest on money and the extra cost of inspection and maintenance, the Committee has been compelled to make substantial advances in the hire charges which have been in operation for over twenty years. Nevertheless, there are at present about 1850 consumers who use hired motors with a total output of over 10,000 horse-power.

IN a long report issued by the French Ministry of Public Works, giving the programme of the schemes to be undertaken by the Government for the improvement of land, river, and maritime transport, one section is devoted to the Channel Tunnel. While many of the schemes included in the programme, as, for instance, the Marne deviation canal and the Rhone-Rhine canal for large vessels, bear after them the words "Still being studied," the Channel Tunnel scheme is placed among those which are ready to be translated from theory to practice. It is stated that the French plans for the Channel Tunnel have been completed.

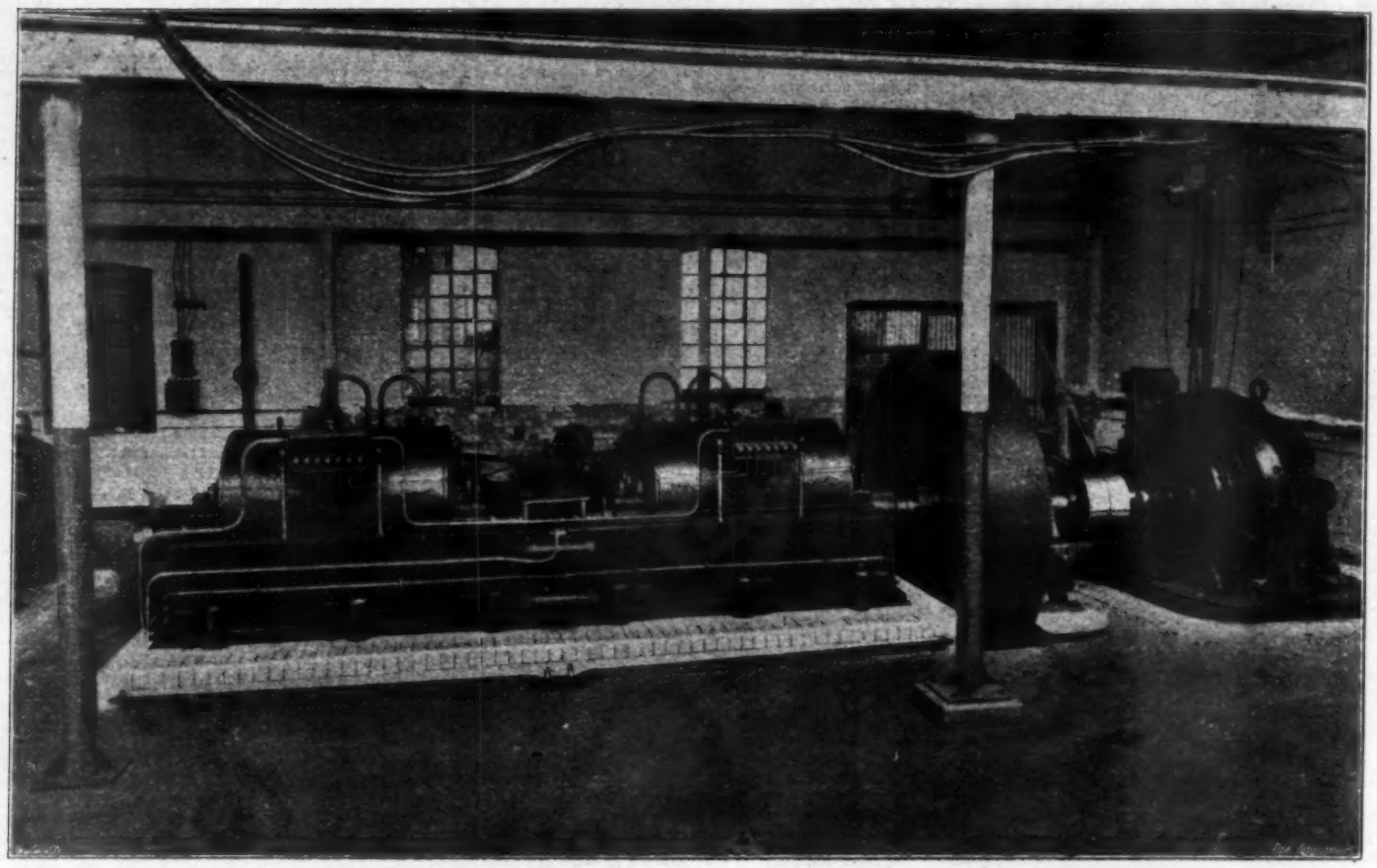
AT a recent meeting of Walsall Town Council a discussion took place on a recommendation of the Electric Supply Committee that in order to provide additional work for the unemployed and subject to Government assistance towards the cost being forthcoming, the electricity mains be extended in Stafford-road, Bloxwich; Lichfield-road, Bloxwich; Birmingham-road and Charlemont-road, Bloxwich-road, Leamore; and Elmore Green-road, Bloxwich, at a total cost of £3070. Mr. Talbot (chairman of the committee) urged that if a Government grant could be obtained the extensions would be in the interests of the undertaking, the need of which was for a larger load, and if this could be secured it would mean a cheapening of current. The recommendation was approved with two dissentients.

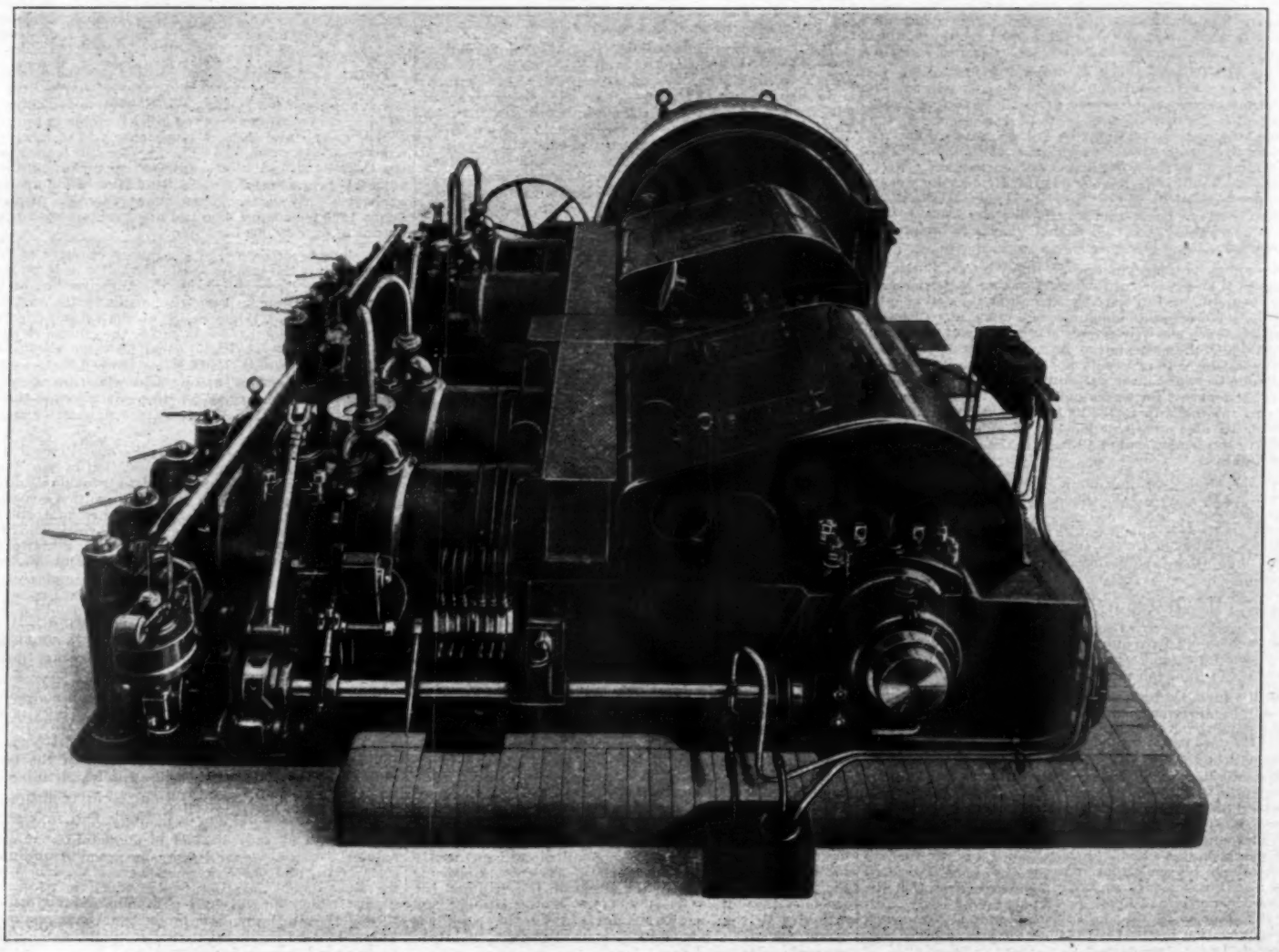
BAMBOOS appear to be the most promising source of paper pulp in India and the Far East, whilst in other countries large grasses, many of which are similar to bamboo in appearance, exist over extensive areas and could be used for the same purpose. In the current number of the *Bulletin* of the Imperial Institute a comprehensive account is given of these giant grasses. Preliminary trials have proved that many of them give a satisfactory yield of pulp, which produces good paper. In the case of the so-called elephant grass of eastern tropical Africa, these results have been confirmed by large-scale trials, and the material has been used in Uganda for Government printing paper, which is of excellent quality. Such grasses, by reason of their bulk, could not be exported to Europe at a profit, but it is suggested that they might be employed locally for paper-making or for conversion into pulp for export.

400-H.P. WASTE WOOD SUCTION GAS ENGINE

FIELDING AND PLATT, LIMITED, GLOUCESTER, ENGINEERS

(*For description see page 547*)





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SOUTH AMERICAN BRANCH OFFICE OF

The Engineer.

526, Bolsa de Comercio, Buenos Aires.

SUBSCRIPTIONS.

The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.

If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive The Engineer weekly and post free. Subscriptions sent by Post Office Order must be made payable to The Engineer and accompanied by letter of advice to the Publisher.

Thin Paper Copies.		Thick Paper Copies.	
Half-yearly ..	£1 11s. 6d.	Half-yearly ..	£1 13s. 0d.
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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

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THE ENGINEER.

NOVEMBER 18, 1921.

The Limitation of Naval Armaments.

Our American friends have never favoured half-measures, and they have taken a characteristic line in drawing up their scheme for the limitation of naval armaments. It may safely be said that such drastic proposals had not been anticipated—in this country at all events—and, as a matter of fact, they go far beyond the unofficial forecasts. A belief was prevalent that warships actually under construction, and particularly those which were far advanced towards completion, would be exempted from any "scrapping" process likely to be advocated; and, further, that the suggestions would be framed, not so much with the object of suspending construction now in hand, as with preventing the subsequent expansion of current programmes. All these suppositions have been falsified by the text of Mr. Hughes' statement. What the United States proposes is absolutely to suspend all capital ship construction for a period of ten years, and to make the arrangement retrospective. The very boldness and simplicity of the scheme may appear at first sight to be its best recommendation. It is only when we come to examine the existing naval situation that doubts begin to obtrude themselves as to the feasibility of the idea. We in this country are, as it happens, able to judge the matter impartially, because we have not at the moment a single heavy warship in hand. It is true that orders have been given out recently for the four battle-cruisers destined to replace eight older vessels, but since the keels have not yet been laid we are only committed to certain initial expenditure on contracts for material and equipment. If these vessels were cancelled it would, of course, be a serious blow to the national industry, for the Admiralty has announced that some 500 firms and 25,000 workpeople would directly benefit from their construction. On the other hand, an enormous amount of money would be liberated for expenditure in other directions. The aggregate first cost of the ships has been officially returned as £30,000,000 or thereabouts—a substantial sum in itself; but it is well known that the expenditure on ancillary docks and harbour works at home and overseas, necessitated by the new building programme, would have run into many millions, and the total bill for ships, docks, and base extensions could scarcely be less than £50,000,000, without counting the cost of maintaining the vessels in commission. If, therefore, it can be shown that no vital interest of the nation would be imperilled thereby, the abandonment of the battle-cruiser programme would be an occasion for rejoicing.

Very different, however, is the position in the United States and Japan. There could be no clearer evidence of America's sincerity in putting forward the proposal than the fact that its adoption would involve her in heavy financial loss. She is building at present a whole fleet of capital ships—nine battleships and six battle-cruisers—all of which she is prepared to discard if we and Japan accept her scheme. This is "scrapping" with a vengeance, for although most of the ships are still in an early stage of construction, the contracts for their guns, armour, &c., are well in hand and could only be revoked by the payment of large indemnities. Japan is not so heavily committed, but in her case there are circumstances which may cause her to hesitate before embracing the American plan in its entirety. She is invited, not merely to tear up her programme of ships about to be laid down—the battleships Owari and Kii, two others not yet named, and six battle-cruisers—but also to "scrap" five capital ships now being built. These are the battleships Mutsu, Kaga, and Tosa, and the battle-cruisers Amagi and Akagi. The Mutsu is so far advanced that news of her preliminary trials is daily expected, and the remaining four are all due to be launched before the end of the year. Expenditure on these five ships to date is estimated at £25,000,000. By comparison with the United States or with ourselves Japan is not a wealthy country. Indeed, it is common knowledge that she has had a hard struggle to provide the money for her naval armaments, which, together with expenditure on the military forces, absorb no less than half her total revenue. Moreover, the Japanese shipbuilding industry has been severely hit by the world-wide slump in mercantile shipping. Having scarcely any mercantile orders in hand, the shipyards are in a precarious situation, and, as has been repeatedly admitted, they are dependent on naval contracts to tide them over the present period of depression. Were a naval holiday to be proclaimed, the effects on the industry would be disastrous, and such wide circles in Japan are now financially interested in shipbuilding enterprises that on these grounds, if on no other, the American proposals are sure to encounter some measure of opposition. We need hardly say that our purpose in thus setting forth certain of the practical difficulties which stand in the way of the "naval holiday" is not to discourage enthusiasm for a noble and lofty ideal, but merely to check unthinking optimism. The more frankly all obstacles are faced, the better the prospect of overcoming them. Turning now to the proposed deletion of ships already in service, we observe that the American suggestions conform to the broad principle laid down by Mr. Hughes, that "in general, regard should be had to the existing naval strength of the Powers concerned." On no other grounds would it be possible to justify the destruction of such ships as our four "Orions," when older and feebler American ships are to be spared. The Orion and her sisters, completed in 1912, each displace 22,500 tons and mount ten 13.5in. guns. It is proposed that they should be broken up, while the American "Delaware" class, completed two years earlier, displacing only 20,000 tons, and armed with ten 12in. guns, are to continue in service. After getting rid of the "Orions" and everything below them, we should be left with the following battleships:—Three "King George V." class, one "Erin," four "Iron Dukes," five "Queen Elizabeths," and five "Royal Sovereigns." These eighteen ships make an imposing array on paper, but it has to be remembered that all belong to the pre-Jutland era, and therefore embody defects which international naval opinion has declared to be irremediable, and that the latest of them were laid down as long ago as 1914. The corresponding American battleship fleet would comprise the following units:—Two "Delawares," two "Utahs," two "Arkansas," two "Texas," two "Nevadas," two "Pennsylvanias," three "New Mexicos," two "Californias," one "Maryland"—eighteen in all, of which number six were begun subsequent to the year 1914, and three after the Battle of Jutland. Even when due allowance is made for the possibly exaggerated distinction between pre-Jutland and post-Jutland designs, it is manifest that in age and general quality the American fleet would have a decided superiority, which, however, would be largely negatived by the four battle-cruisers which we should be permitted to retain. There is, we repeat, no question of America's whole-hearted sincerity in submitting this plan. Naval critics have often pointed out the handicap under which the United States Navy would labour in case of war by reason of its lack of battle-cruisers; yet while America is ready to cancel the six ships of this type which she is now building, she raises no objection to the inclusion of four battle-cruisers in our own Navy and four in the Japanese. This is an earnest of good faith which will doubtless be appreciated more by naval students than the general public.

Some objection, we notice, has already been raised against the stipulations governing the replacement of obsolete ships at the end of ten years, according

to which Great Britain would be debarred from building new vessels as substitutes, owing to her higher margin of aggregate tonnage, while the United States would be free to lay down six new capital ships. Apart from the certainty that such inequalities will be adjusted before the scheme assumes concrete form, it is more than possible that developments in aeronautics and submarine navigation will produce in the course of the next decade a marked change in the present standards by which naval power is measured. Although the battleship remains supreme for the time being, no one can affirm with confidence that her prestige will stand as high ten years hence. Since there is nothing in the proposals which inhibits the prosecution of research and experiment in the domain of naval science, it is extremely likely that weapons such as the torpedo and the mine will have undergone great improvement before the time arrives for laying down new capital ships. By then, perhaps, the degree of progress achieved in respect of these and other weapons may be such as to render the battleship obsolete. We observe that allowance is made in the scheme for a large aggregate tonnage of aircraft carriers, 80,000 tons being allotted to the United States and Great Britain respectively, and 48,000 tons to Japan. These figures are of special significance, for the American navy has now only two such ships, with a total of about 28,000 tons. The inference is, therefore, that several new aircraft carriers are to be built. We do not attach great importance to the proposed restrictions on aggregate submarine tonnage. In this type of vessel displacement is not necessarily an index to fighting power. In the Pacific, for instance, the strategical conditions are such that a few submarines of great cruising radius would be far more valuable than thrice the number of smaller boats with a very limited sea endurance. These, however, are details of minor importance compared with the great issue which the American proposals have raised. The reception they have already met with here shows that in this country, there is every desire to co-operate in the noble task to which America's statesmen have applied themselves. Our own belief is that it will be accomplished, provided that the political differences which give rise to competition in armaments are approached and discussed with the same sincerity and breadth of view which characterise the proposals for reducing naval establishments.

Research Associations.

THE Department of Scientific and Industrial Research, which was established for the purpose of securing the advancement of our national industries by the application of science, must, in the end, stand or fall by the benefit which those industries derive from its activities. For good or ill, the Department has pinned its faith to the policy, now widely known and understood, of fostering the formation of "Research Associations," which, with the aid of Government funds, are intended to carry out co-operatively for each entire industry both actual research and the application of scientific knowledge and methods to their own industrial problems. We believe that it was hoped and expected that each of these associations would set up great research laboratories and experimental plants of their own and that they would bring about an intensive application of the best that science can give to our industrial needs. A considerable number of actual Research Associations has now been formed, and some of them have been in active existence for periods of from two to three years. It is not, perhaps, unnatural to inquire what they have so far achieved or, at least, how their activities are progressing.

In making such an inquiry we do not wish to be classed with those who expect to obtain direct industrial results from scientific research within a few months or even within a year or two. It would be unreasonable to look for substantial industrial results at this comparatively early stage. Even if scientific results had already been achieved on a considerable scale, the existing industrial conditions would not yet have allowed our industries to make any extensive use of them. But it is pertinent and indeed necessary to inquire how the activities of these Research Associations are developing, and whether we may with any degree of certainty count upon really valuable results being obtained. Since the activities of most of them are shrouded beneath the word "confidential," it is somewhat difficult to ascertain or, at all events, to quote information concerning their working. A few essential facts, however, are well known and serve to indicate the trend of events. Thus it is quite evident that the formation of any considerable number of large and important co-operative research laboratories is not taking place. This is, we think, an unavoidable consequence of the conditions prevailing after the war—scarcity of material of all kinds needed for such a purpose, and particularly scarcity of men adequately trained to take charge of such institutions. The scarcity of men has been illustrated in the notorious difficulty which several of these Associations have had in filling the all-important post of "Director of Research." So long as a "Director" has merely to act as an organiser, seeking to co-ordinate the activities of more eminent men who are carrying on the real research work, the matter is not serious; but if he be called upon to direct a laboratory of his own, then widely different and greater qualifications are needed, and men really capable of initiating and guiding fruitful research are always rare. Actually, what is happening is that the Associations, in so far as they concern themselves with real research at all, are wisely availing themselves of the existing research institutions, such as the universities and the National Physical Laboratory. This is no doubt a good thing, and if it really serves to bring about a more intimate relation between those institutions and our industries some good will have been done. Indeed, so far as actual research is concerned, it might, we suggest, have been more efficient to subsidise those institutions directly and liberally, and to have saved the overhead charges—in many cases very heavy—incurred by the Associations with their paid staffs. Yet it may be hoped that in the end the Associations will justify themselves, for their real functions will arise mainly at a later stage, when it becomes a question of securing the industrial application of the results of researches. We have recently referred to this aspect of the matter in connection with aluminium alloys, but it arises in every case, and it is at this point that the co-operative activity of a Research Association may become vitally important. These Associations will only rarely be able to carry on research themselves; as a rule they can only initiate and support it. But the application of its results on the industrial scale is their most important function, and it is to be hoped that they will realise that fact.

Meanwhile, as every Government Department must expect, much varied criticism has been poured out upon the Research Department and its Research Associations. One criticism is the suggestion that the Research Associations will, ultimately, create a new group of vested interests, and that in the long run research done on their account will not be for the national benefit, but only for the benefit and profit of a small closed monopoly in each industry. Such criticism is based on the fear that any association of an entire industry may, sooner or later, develop into a "ring" or monopoly. This danger, however, has been guarded against as far as seems to be possible, by the articles of association which have been imposed upon these bodies. Yet there is a small danger of this kind which it would be well to see recognised and countered. In many industries there are in existence so-called "Trade Associations," which are merely price-regulating organisations. These bodies already constitute something in the nature of "rings." Now it is evident that these very bodies, which are so completely representative of their industries, should be looked to for financial support for the corresponding Research Association, and it is in itself right and satisfactory that they should utilise their very complete organisation for the purpose of securing to the Research Associations the requisite financial support of the industry. But at that point it is important that their sphere of action should be limited; they must not be allowed to obtain any serious control of the Research Association. Not only are such bodies ill fitted to guide research or assist it, except by financial contributions, but their intimate connection with a Research Association would tend to justify a fear that the results of researches, conducted in part out of public funds, might be used in a selfish and monopolistic manner. This is a matter of considerable importance for the whole future of the Research Association movement, and it is for the Department of Scientific and Industrial Research to see that no danger of this sort shall arise. It would not seem to be unduly difficult to prevent trade associations from securing any serious control of a Research Association, even if they support it with liberal subscriptions, and we trust that the Department will see to it that the young Research Associations are protected from any sort of strangle-hold from business associations having a monopolistic policy.

An Institution of Chemical Engineers.

THE decision to form an Institution of Chemical Engineers, which was reached at an informal dinner and meeting at the Engineers' Club in London on Wednesday, November 9th, may be taken as an indication of the full awakening of this country to the fact that chemical engineering is not merely an integral part of the chemical industry, but a fundamental one. It is now realised that chemical engineers, at least as much as chemists, have been responsible for building up the great German chemical industry. America acknowledged the chemical engineer something like fifteen years ago, and to-day has degrees in chemical engineering in her universities. There is also an American Chemical Engineering Society, whose name it is proposed to alter to the Chemical Engineering Society.

The first step towards placing chemical engineering in this country in its proper place was taken a few years ago, when those members of the Society of Chemical Industry who have self-styled themselves, with good reason, Chemical Engineers, met together with the intention of founding an institution of their own. For reasons which it is not necessary to enter into here, they ultimately decided to form a chemical engineering group of the Society of Chemical Industry. That Society has done exceedingly good work of an educational nature, but the necessity still remains for the existence of some body which can, among other things, take in hand the question of the qualifications of a chemical engineer, raise the standard, prohibit unprofessional conduct, co-operate with the educational institutions for the improvement of men who enter the profession of chemical engineering, and do the many things which apparently the present societies in the chemical industry are unable to do. The work of the Chemical Engineering Group has been limited. Moreover, things have developed a good deal since it was first formed, and there is a general acceptance of the view that the chemical engineer must be a special breed, which will not be a substitute for the chemist as such nor the engineer as such. The old feeling that a chemist with some engineering knowledge, or an engineer with some chemical knowledge, could rank as a chemical engineer has disappeared. The belief that a special institution is necessary came into existence very soon after the formation of the Chemical Engineering Group; indeed, it existed in the minds of some even at that time. An attempt was made to form an institution of the kind at the time of the annual meeting of the Society of Chemical Industry in Newcastle in 1919; but although the general feeling was in favour, it was felt that the meeting was not sufficiently representative. Now, however, there is no doubt of the opinion among those concerned. Professor J. W. Hinchley, the past chairman of the Chemical Engineering Group, and Mr. H. Talbot, its honorary secretary, who have been the prime movers, received a hint that if London did not do something towards forming an Institution of Chemical Engineers, Manchester would. That, in a way, brought the matter to a head. The meeting last week was presided over by Sir Arthur Duckham, and men were present from as far as Glasgow, as well as all the large industrial towns, such as Manchester, Sheffield, Birmingham, and Huddersfield.

The only misgiving is that here we have another institution added to the already over-long list. Yet no other course seems open, and if, as Sir Arthur Duckham suggested, the formation of this new institution brings more quickly the day when all our engineering institutions will amalgamate into one central organisation, then, if for no other reason, it will have served a good purpose. A provisional committee has been formed, including Sir Arthur Duckham and Mr. W. J. N. Woolcock, who is general manager of the Association of British Chemical Manufacturers, and is also associated with the British Chemical Plant Manufacturers' Association.

Literature.

Memoir on the Coalfields of Ireland. July, 1921. Vol. I., Text; Vol. II., Maps. Dublin: The Commission of Inquiry into the Resources and Industries of Ireland, American Chambers, 15, Lower O'Connell-street.

By the majority of the inhabitants of these islands Ireland has probably been regarded as being, until quite recently, a seething mass of rebellion where scientific and exhaustive enquiries could not safely or efficiently be carried on. Yet for some time past a Power Committee, appointed by the Commission of Inquiry into the Resources and Industries of Ireland, has been going about the island from north to south and from east to west, making minute investigations as to the coalfields of the country. So far, indeed, is it from making complaints as to its reception, that it expresses, in a Memoir which was published a short time ago, its deep appreciation of the hospitality extended to its delegations. As a result of its investigations the Committee has managed to compile a particularly interesting volume, the value of which is considerably enhanced by the fact that side by side with it is published a series of very instructive maps.

The Committee, as its first act, divided its subjects of reference under the heads of the sources from which power in Ireland might be derived—that is to say, under the heads of coal, peat, water, and industrial alcohol, and it proceeded to hear evidence under each of those heads. It soon became evident to it, however, that the information available in the form of evidence with regard to coal resources was limited in extent and disconnected in form. It was therefore decided that a memoir on the subject should be written and that it should present in clear and sequential form the exact state of present knowledge with regard to those resources. The result was the volume at present under consideration, which extends to some 400 pages and is illustrated with eight specially prepared coloured maps.

The procedure adopted, as the work proceeded, was for the Power Committee to appoint, from time to time, delegations of its own members to visit the various coalfields with the information at their disposal. The delegation having ascertained the present conditions of the field, the investigation of which had been entrusted to it, made a report to the Committee, and a section of the Memoir was then written with that report as a basis, all other information from written and other sources being included, with the result that the Memoir undoubtedly forms the most complete work concerning the coal-bearing areas of Ireland which has hitherto been published. Each of the following coalfields is dealt with in detail in a separate chapter :—

The Leinster ;
The Slieve Ardagh or Tipperary ;
The Munster ;
The Connaught or Arigna ;
The Ballycastle ;
The Loch Neagh.

In addition, there is added a chapter entitled "Patches," which deals with certain smaller coal areas which cannot be included under the headings of any of the larger coalfields, but in which the coals are of local value or in which it has been reported that coal has been found. There are, it appears, three such "patches." The first, which is near Balla, in the County Mayo, is described as being of no importance, the coal seams having been denuded, leaving only the carbonaceous shale beneath them. The next is south of Carrickmacross, at the junction of Counties Monaghan, Cavan, Louth, and Meath ; the third in the neighbourhood of Kilnaleck, in the County Cavan. Both of these small patches, although they do not contain coals to any substantial extent and are only of local value, are nevertheless of considerable interest. The first represents a small fragment of Coal Measures that were preserved from denudation under the break of a fault, while the Kilnaleck patch is a geological curiosity. The coal found there is not contained in what are known as the Coal Measures proper, but in the Silurian Measures far beneath the coal deposits. They are, therefore, not normal coals at all, but of a geological age far earlier than the time when the carboniferous deposits were first laid. Furthermore, they do not occur in seams, but in bunches and lenses that appear and die out in a very irregular fashion. In none of the three patches, however, are the coals of any substantial extent, though they are of local value.

As concerns the Leinster coalfield, it is stated that it extends over some 94 square miles through the counties of Kilkenny and Carlow and Queen's County. It consists of a high basin-shaped plateau, raised above the surrounding limestone plain, about 20 miles long from north to south and 12 miles wide in the broadest part from east to west. The lowest coals outcrop on the hills forming the outer edge of this basin, as also on some of the lesser elevations within the basin. The coal measures, it is explained, may be said to form a basin, but, like all strata lying in the course of the Hercynian movement, they are considerably faulted and folded, forming irregular synclines and anticlines within the basin. Throughout the area the upper coal measures are entirely absent, the series of strata containing those measures having been eroded and denuded. As the result of that denudation and erosion the deposits remaining of the Middle Measures were not at any time large, and what little there was has nearly all been extracted as the result of the workings carried out during the last two or three hundred years, though a small portion is still to be found in the Jarrow seam. The principal coal reserves in this area at the present time are, therefore, contained in the lower coal measures. The reserves of the whole of the Leinster coalfield are estimated at 299,000,000 tons, but it is apparently doubtful whether a fairly large percentage of that quantity could be economically won under existing conditions.

The Slieve Ardagh coalfield, which is sometimes referred to as the "Tipperary," is a comparatively small coal-bearing area, which is situated in the Slieve Ardagh Hills, in the county of Tipperary, and which extends to not more than 20 square miles. It consists of a series of synclines or small basins that lie nearly lip to lip. It is looked upon by geologists as having originally formed part of the Leinster coalfield, from which it became disconnected by the denudations of former times. Much of the coal which originally existed has either been worked out, and in many districts in the area what remains is not worth taking account of ; but it is estimated that the reserves amount to some 40,000,000 tons.

With regard to the Munster coalfields, it is pointed out that all previously existing estimates of the coal resources of Ireland entirely neglect them. Yet they cover an area which spreads over large portions of the counties of Cork, Kerry, Limerick and Clare, is said to be the largest coal formation in the British Empire, and is estimated to cover 640 square miles. As is remarked, however, while it may be technically true that the coalfield comprises the largest area of coal formation in Ireland or any other part of the Empire, that fact does not necessarily imply that it contains an amount of coal commensurate with so great an area. As a matter of fact, comparatively little is known about the extent of the deposits. What is known is that the coal is anthracite with a large proportion of culm, and that the seams all dip at very high angles. In many instances they are vertical, at right angles to the horizon, while frequently they are inverted, the fire-clay seat becoming the roof, which indicates the extremely violent character of the disturbances to which the area was subjected in early geological times, and would account for the crushed nature of much of the coal and the large proportion of culm. With such conditions it is manifestly difficult to arrive at any accurate computation as to the amount of coal available ; yet the figure of 1,570,000,000 tons is put forward as being a conjectural estimate of the likely minimum resources.

The coals contained in the Leinster, Slieve Ardagh, and Munster fields are all anthracite. The next field dealt with—the Connaught or Arigna—contains semi-anthracite. It is situated in the more or less isolated area surrounding Loch Allen, at the junction of the three counties of Roscommon, Leitrim, and Sligo, and extends, it is said, to about 158 square miles. The estimate given of its reserves of coal is 29,666,000 tons.

The Ballycastle field, which contains bituminous coals, is quite small, occupying only 5 square miles and embracing the entire promontory at Benmore as well as a patch at the south-west of that promontory. The estimated reserves in it amount to 49,622,000 tons.

In the case of all these coalfields the Memoir gives a general survey, then discusses known seams and the extent to which they have been worked, gives analyses of the coal, and discusses transport facilities.

Following the chapters devoted to them, attention is paid to the concealed coalfields of Loch Neagh, Larne, Ballymoney, and Portrush, the coals of which are all given as being bituminous. The existence of the last two, however, appears to be conjectural, though it is stated that there are sound geological reasons for believing that such coalfields are present beneath the basalt cover of the north-east of Ireland.

Of the work as a whole, which with its various appendices contains much that space has prevented us from mentioning, it may be said that it has been prepared with evident care and that, besides being a valuable work of reference, it will be read by many with a great amount of pleasure and interest.

BOOKS RECEIVED.

English for the English. By G. Sampson. Cambridge : At the University Press. Price 5s. net.

Iron Foundry Practice. By G. J. Pitt. London : Cassell and Co., Limited, La Belle Sauvage, E.C. 4. Price 6s. net.

Steam Boilers. By Terrell Croft. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 24s. net.

Mine Accounting and Cost Principles. By T. O. McGrath. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 24s. net.

Railroad Shop Practice : Methods and Tools. By F. A. Stanley. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 24s. net.

American Sulphuric Acid Practice. By Philip De Wolf and E. L. Larison, with a special chapter by W. M. Le Clear. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 21s. net.

The Design of Highway Bridges of Steel, Timber and Concrete. By Milo S. Kitchum. Second edition. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 30s. net.

The Working of Steel : Annealing, Heat-treating and Hardening of Carbon and Alloy Steel. By F. H. Colvin and K. A. Juthe. London : McGraw-Hill Book Company, 6 and 8, Bouverie-street, E.C. 4. Price 18s. net.

Electricity in the Service of Man. A popular and practical treatise on the applications of electricity to modern life. By R. M. Walmsley. Vol. II., Section 3, *The Technology of Electricity.* London : Cassell and Co., Limited, La Belle Sauvage, E.C. 4 Price 15s. net.

Iron and Steel Production in October

THE following notes are taken from a memorandum issued by the National Federation of Iron and Steel Manufacturers.

Although a settlement of the coal dispute was arrived at at the end of June, by the end of October there were still only 82 blast-furnaces in operation, compared with 109 before the stoppage and 300 in September, 1920. The production of pig iron in October amounted to 235,500 tons, of which 80,200 tons were hematite, 63,300 tons basic, 74,500 tons foundry, and 13,600 tons forge, with a small quantity of alloys and other qualities ; the production of steel ingots and castings amounted to 405,400 tons.

Although the output of pig iron is increasing, it is still below the very low output of March last and little more than one-third of the average monthly output of 1920. In the case of steel there has actually been a decrease since August, a decrease which would have been much more marked but for the remarkable recovery in South Wales, where the October production amounted to 133,100 tons, or 86 per cent. of the average monthly production in 1920. Excluding South Wales, production dropped from 369,400 tons to 272,300 tons, or by 26 per cent., between August and October.

Prices.—That manufacturers are doing all they can to encourage demand is manifest from the above table of prices, which shows that the present price of typcal iron and steel products is considerably less than half the maximum price ruling towards the end of last year, and in most cases no more than 30 per cent. to 60 per cent. above the average price of 1913. That these drastic cuts have not been sufficient to stimulate demand is due to the fact that continental prices expressed in sterling are even still lower than British. On account of the depreciated exchanges, German prices are, of course, extremely low, but, fortunately for British industry, Germany cannot for the moment guarantee delivery. The vital comparison, therefore, is with France and Belgium, who, even with the addition of transport charges, are able to deliver here below the British price.

Costs.—Towards the reduction in price reduced wages have contributed substantially. As the current *Labour Gazette* shows, the wages of workers in the iron and steel industry have fallen in the first nine months of the year by 27s. 6d. per week, and have fallen more than those of any other class of worker.

Fuel costs have also been reduced, for the price of metallurgical coke is largely governed by what the iron and steel industry can afford to pay, and the price in many districts has therefore fallen considerably ; in Lincolnshire, for instance, they are only 60 per cent. above pre-war.

Rail Rates.—But still further reductions in cost must be made if we are to compete, and further contributions may still have to be made in lower wages and prices of material. Steel makers are, however, of opinion that in the present abnormal conditions some special reduction in railway rates, which are an important item in costs, is essential. Representatives of the industry therefore submitted their views to the railway companies at a meeting which took place last week, and placed the relevant facts and figures before them. The railway companies had already recognised the exceptional position of the industry, and reductions on ore and limestone took place on November 1st. These reductions are, however, unequal and inadequate. Unequal, since they afford no help at all to works whose coal has to be brought from a distance ; and inadequate, since a reduction on these two commodities reduces the transport bill of the industry by no more than 4 per cent.

The industry feels that it is now faced with the difficulty which was foreseen when the principle of the standard revenue was put forward in the Railways Bill. At a time when all industries are working at a loss it is obviously inimical to the country's interest that the railways should attempt to maintain their rates at a high level in order to provide a standard revenue. On the contrary, their policy should be to take the risk of loss in common with other industrial enterprises and lower rates in the hope that by so doing they will assist to bring back trade to Great Britain.

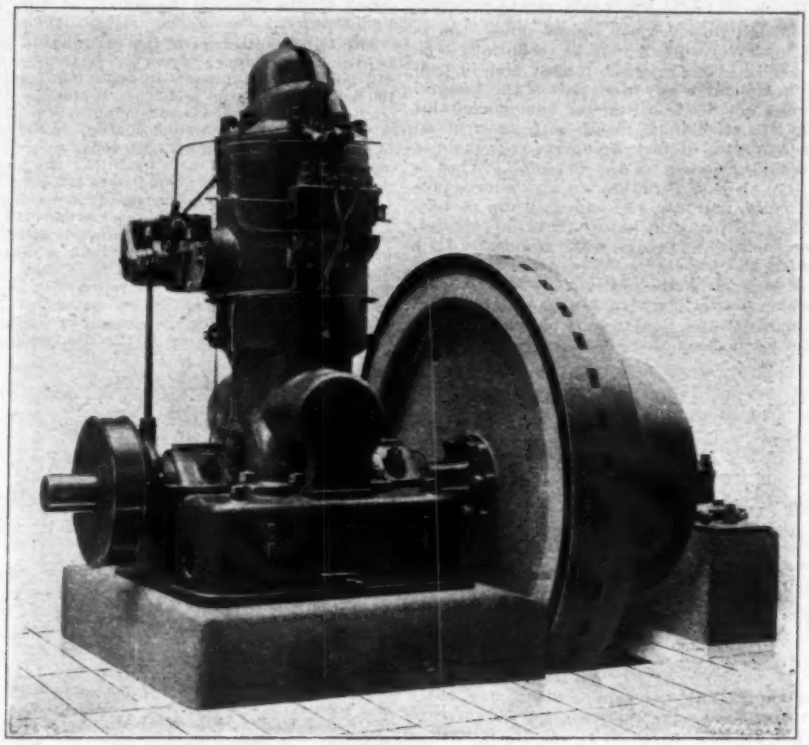
Prices of Iron and Steel Products.

	Average price, 1913.	Maximum price, post-war.	Present price.	Percentage increase over pre-war.	France, £ = 54f.	Belgium, £ = 56f.	Germany, £ = 1200 marks.
	£ s.	£ s.	£ s.				
Cleveland No. 3	2 19	11 5	5 10	86.4	180f. (£3 7s.)	235–240 (£4 6s.)	2124 (£1 16s.)
Billets (Scotland)	6 17	26 10	7 5	5.8	340 (£6 3s.)	345 (£6 3s.)	2725 (£2 6s.)
Rails	6 13	25 0	10 10	57.9	550 (£10 4s.)	485-500 (£8 18s.)	—
Ship plates	7 17	24 10	10 10	33.7	710 (£13 3s.)	500–510 (£9)	3500 (£2 18s.)
Tin-plates (per box)	0 14	3 18	1 2	57.1	—	—	—
Joists	7 3	24 0	10 10	46.8	475 (£8 16s.)	420–430 (£7 12s.)	3150 (£2 14s.)
Angles	7 0	25 0	10 0	34.2	?	440–445 (£7 19s.)	3150 (£2 14s.)

A GENERAL review of Russian industry based on material supplied to the Russian Official Economic Journal, *Ekonomiteskaya Zhiem*, and referring to the electrical industry in the first quarter of 1921, says that the number of workers engaged in the principal factories in that period had risen from 6708 to 7668, or by 14 per cent., whilst other employees had increased in number by 7 per cent., but the increase in the number of workmen did not result in a corresponding output of goods, which was partly due to the lack of skill, which was particularly shown in the quality of the work. Compared with the last quarter of 1920, no improvement is reported. The output in some factories increased ; in others it decreased. The principal causes of the continuous unsatisfactory industrial output are again said to be the poor supply of fuel and the food crisis, which for many months now have been a leading feature in the economic situation at Kharkoff and Petrograd.

VERTICAL TWO-CYCLE OIL ENGINE

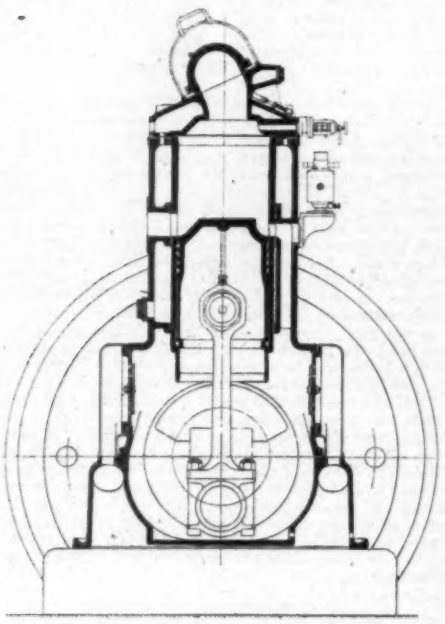
MARSHALL, SONS AND CO., LIMITED, GAINSBOROUGH, ENGINEERS



A Two-Cycle Oil Engine.

During a recent visit to the Gainsborough works of Marshall, Sons and Co., Limited, we saw on the test bed two examples of a new type of oil engine which that firm is arranging to manufacture in considerable quantities. A large double-bayed building which was used during the war for ordnance has, in fact, been put aside solely for erecting and testing these engines.

The two-stroke hot bulb type of engine has been adopted, and, as will be seen from the illustrations, the exterior design follows somewhat closely the appearance of several other engines of this type. This resemblance is perhaps more striking in the case of the vertical engine



SECTION THROUGH OIL ENGINE

than in the horizontal sets. There are, however, indications throughout the detail parts of these engines that the makers have profited by their long experience in the production of steam engines and have taken advantage of the lessons learned by other makers of heavy oil engines.

On glancing at the illustration of the vertical engine above, for instance, the substantial character of the fuel pump bracket will be noticed. At first it may not appear that any very great strength is needed for such a service, but when it is remembered that a force of several hundreds of pounds has to be employed to inject the oil and must be exerted through a small fraction of an inch with a high degree of exactitude, the necessity for rigidity in the parts of the pump gear will be appreciated. The pump itself is of the simple plunger type, with ball valves, and is operated by an excentric through a bell-crank lever carried in a bracket on the side of the main cylinder. The engine is governed by varying the stroke of the fuel pump through alteration in the throw of the excentric. The excentric sheave is made in two parts, one fixed to the shaft and the other sliding excentrically upon it. The latter part is connected with the centrifugal shaft governor and the throw of the pump is thus under the control of the governor. At the same time as the governor alters the stroke of the pump it regulates the time of admission of the charge so as to ensure satisfactory firing regardless of the load on the engine. A small hand lever is provided for holding the valve plunger clear of the bell crank when it is desired to stop the engine, and this lever can also be used to give an extra injection of fuel if it is required on starting up. The injection spray is arranged in a little recess cast in the front of the cylinder head, and is held in place against its seating by means of a single set screw, so that it is a very simple matter to remove the spray for cleaning. Facing the spray in the combustion chamber there is a nickel plug which provides a hot spot for facilitating starting. The fuel oil is passed through a box, on its way to the pump, which is heated by the exhaust gases, but can be by-passed round the box in hot weather or when light oil is being used.

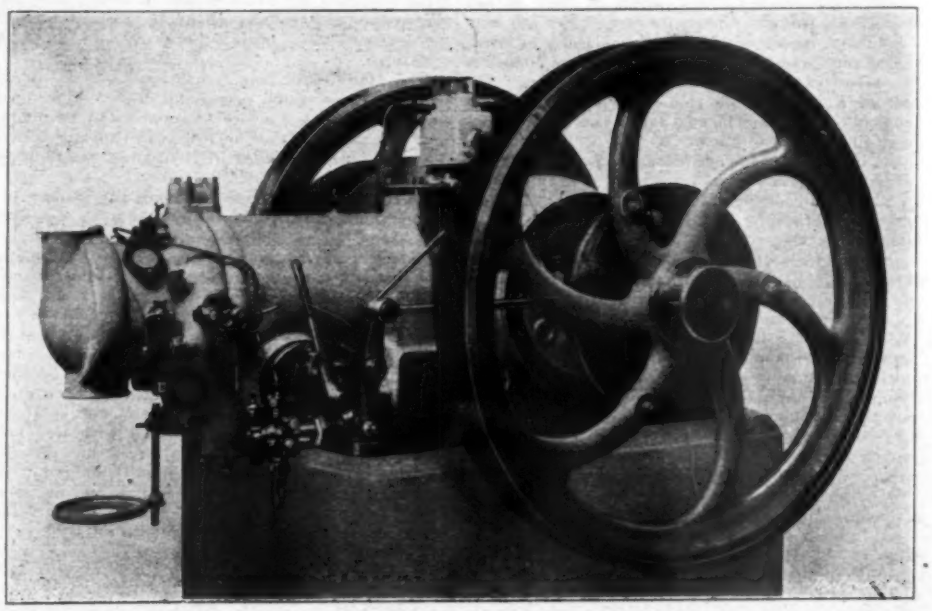
On referring to the line drawing, it will be noticed that the piston is of the form which has become practically universal in this class of engine, while the combustion chamber is of a well-tried shape. The connecting-rod follows closely the design adopted by the makers for some of their steam engines, and has a marine type big end bearing. The gudgeon pin is lubricated with oil scraped off the cylinder wall by a little brass fitting which is held up to its work by a spring, while the crank pin gets its oil from a banjo arrangement. The oil is supplied by a forced sight-feed lubricator of the type which Messrs. Marshall have adopted on their steam engines for some time past. It is fixed on the front of the cylinder, and is driven from the fuel pump bell crank. The main crank shaft bearings have ring lubrication.

In the horizontal type of engine the same general principles have been adopted, but in this case the cylinder and bed are cast in one piece. The crank case entirely surrounds the crank shaft, which is threaded into place endways. The openings in the sides of the case are thus made large enough to pass the crank webs, and are closed by circular covers which carry the main bearings. The arrangement makes the engine compact and provides a very rigid connection between the crank shaft and the cylinder. The gear for driving the fuel pump is slightly modified, as will be seen from the engravings, but the details remain the same as in the vertical engine. Compressed air is used for starting both engines, and is admitted by a simple lever-operated hand valve in the cylinder head.

In the case of the horizontal engines a single cylinder is adopted for all sizes and ranges from 7in. in diameter by 9in. stroke for 8 brake horse-power, up to 10½in. by 13in. for 25 horse-power. The corresponding speeds are 380 revolutions per minute and 300 revolutions per minute respectively.

The vertical engines have from one to four cylinders according to the power required, while there are four sizes of cylinder giving 30, 40, 50, and 75 horse-power each. The smallest cylinder is 11½in. in diameter by 13in. stroke, and the largest 16½in. by 17in. It will thus be seen that with four cylinders 300 horse-power can be obtained. This engine runs at 250 revolutions per minute, and the smallest size at 325 revolutions.

On the occasion of our visit the engines were using a Texas oil, but the makers informed us that they will burn practically any oil which is on the market. The best results are obtained with fuels having a specific gravity of from 0.85 to 0.9 and a calorific value of not less than 19,000 B.Th.U. per pound. With such an oil the consumption is guaranteed to be not more than half a pint per brake horse-power per hour. The mean effective pressure in the cylinder is about 40 lb. or 43 lb. per square inch, while the compression pressure is 150 lb., which is sufficient to ensure the firing of the charge but is not so great as to cause difficulty in starting. The air is compressed to about 4 lb. per square inch in the crank chamber. No arrangements for water injection in the combustion chamber have been provided, as it has been found that the engine will work quite satisfactorily at all loads without that complication.



HORIZONTAL TYPE, MARSHALL OIL ENGINE

Training and Examination of Chemistry Students.—It has just been announced by the Board of Education that the Institute of Chemistry has consented to co-operate with it in arrangments for the award of certificates in chemistry and applied chemistry to students in technical schools and colleges in England and Wales. Under the agreement which has been reached, certificates will be issued jointly by the Institute and the Board on the successful completion of approved courses. The scheme will provide both for full-time students and for part-time students. Detailed arrangements for the administration of the scheme will be published shortly. The Board understands that the Institute will consider at a later date whether and how far the training and the higher certificates may qualify for admission to the examination for the diploma of associateship of the Institute. Should the authorities of any school in England desire further information, their inquiries should be addressed, till the detailed arrangements are published, to the Expert Inspector to whom the chemistry courses of the school are assigned for inspection. Inquiries from the authorities of schools in Wales should be addressed to the Permanent Secretary, Welsh Department, Board of Education.

A High-Speed Blue Printing Machine

A NEW type of photo-printing machine that has just been brought out by B. J. Hall and Co., Limited, of Chalfont House, Great Peter-street, London, S.W., and which represents a very considerable advance in the construction of this class of apparatus, is shown in the accompanying illustrations.

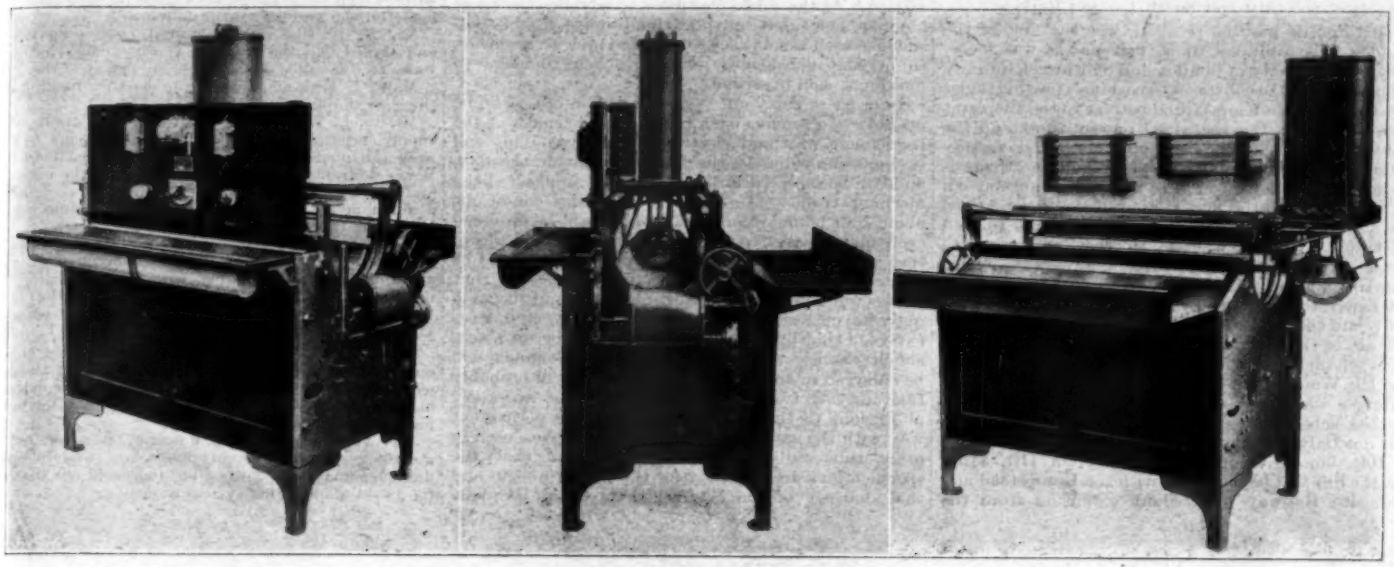


FIG. 1—THE "HALL-MARK" CONTINUOUS PHOTO-PRINTING MACHINE

The machine is of the type in which the tracing and sensitised paper are drawn across a glass plate on the opposite side of which there is a source of light, and is distinguished from others of its class on account of the closeness of the lamp to the glass, and the consequent increase in the intensity of the illumination. The action of the light is, in fact, so powerful that double-elephant blue prints can be made at the rate of 130 copies per hour, while the speed for gallic prints is from 40 to 45 per hour. In the latter respect the new machine is specially noteworthy as there is a tendency for gallic paper to become sticky if it is overheated. The glass is, however, so disposed that the heat which it receives from the lamp is quickly dissipated by radiation and conduction, and we have noticed that even after the machine has been running quite a considerable time the glass is not more than comfortably warm.

The intense actinic light which permits these high speeds of printing is obtained from a new type of arc lamp, known as the Hall-Thorkelin, of which we give a line drawing in Fig. 3. It will be noticed that the carbons are arranged at such an angle that the electric arc throws an uninterrupted light in a downward direction. The carbons are held in scissors-like arms, which are connected at their upper ends with an iron counterweight

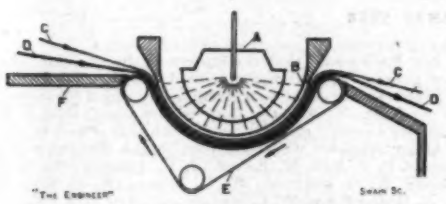


FIG. 2—DIAGRAM OF PHOTO-PRINTING MACHINE

hanging inside a solenoid. This solenoid both strikes the arc and feeds the carbons forward as they burn away. The feed is some 4in. for each carbon. The arc is remarkably steady even when drawn out to a length of about ⅛in., and does not appear to move about in the craters of the carbons. The current consumption is some 10 ampères, which is, of course, much less than that required by many photo-printing arc lamps. The glass globe is not quite 4in. in radius, which permits the lamp, as we have already mentioned, to be brought very close to its work.

The glass bend is arranged, as will be seen from the half-tone engravings Fig. 1 and the sketch Fig. 2, in a horizontal position, with its concave face uppermost. The arc lamp is made to travel backwards and forwards in the trough thus provided, while the tracing and sensitised paper are drawn round the outside beneath. In the sketch, A is the arc lamp, B the glass bend, C and D the tracing and paper respectively, and E the travelling canvas band, which keeps C and D in contact with the glass while it feeds them forward. F is the feeding side of the machine. The total width of the glass bend, it will be noticed, is comparatively small, with the result that the canvas band can be drawn tight, to keep the tracing and paper in good contact without producing so much friction on the glass that a large amount of power is required to keep the system moving. That this is actually the case may be judged from the fact that the whole machine is driven by a ½ horse-power motor, which starts comfortably when switched directly on to the mains.

The driving mechanism for the lamp and the canvas band are interconnected and are driven off the motor just mentioned through a pair of coned pulleys, along which the belt can be moved to give a gradual variation in the speed. There is also a two-speed gear-box, which can be seen on the end of the machine in Fig. 1, so proportioned that it doubles the range of speed given by the cone pulleys without any intermediate gap. The driven shaft of the gear-box carries a worm and also a sprocket wheel. The worm is geared with one of the rollers round which the canvas band is wrapped, while the sprocket operates a countershaft in the base of the machine. An ordinary bicycle chain passes round this countershaft and round another wheel at the opposite end of the machine. It is thus kept in continuous movement while the motor is running. There is a stud extending from the side of this chain, and to it are attached the ends of another chain, which runs over pulleys at the ends of the lamp track and is fixed to the lamp carriage. The result is that every time the stud on the first-mentioned chain passes round either of the countershaft pulleys the direction of travel of the lamp is reversed and the lamp works to and fro without any serious jolt at the ends of its stroke. At one end of the lamp track there are two hinged brackets which form extensions of the track when opened out and

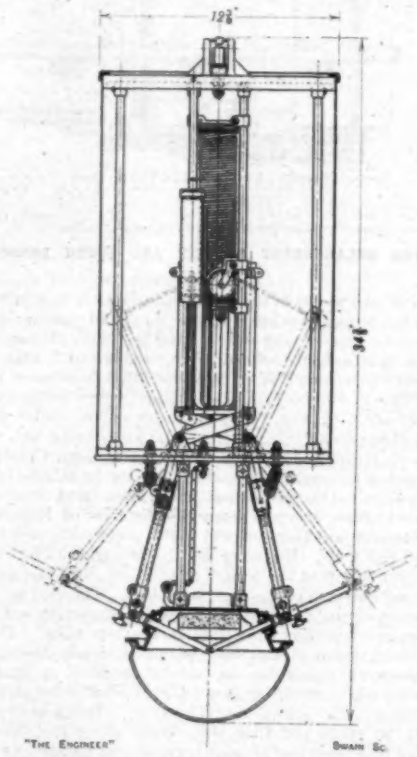


FIG. 3—PHOTO-PRINTING ARC LAMP

provide a sort of dry dock where the lamp can be attended to for cleaning or the renewal of the carbons. One of the views shows these brackets in service.

The lower left-hand roller for the canvas band—see Fig. 3—is carried by bearings which can be pulled down by a spring tension device to regulate the pressure between the band and the glass. When it is required to remove the band this roller is slipped out endways and the other two rollers then lift directly out of their bearings. The glass bend can be taken out of the machine if necessary with equal ease. The main frame of the machine comprises cast aluminium ends, braced together by steel tie rods, with a wooden floor, while the shelves at the feed and discharge sides are of mahogany. On the feed side there is a receptacle for a roll of sensitised paper and a guide to help in cutting it off squarely. The resistances for the arc lamp and all the other electrical accessories are mounted on a board which forms a light screen on the feed side of the machine. It is thus only necessary to make one electrical connection when setting up the printer. The floor space occupied is 7ft. 6in. by 5ft. 3in., while the weight is such that four men can carry the machine.

Since the photographs from which our engravings have been reproduced were made, shields have been arranged at the ends of the glass bend to screen glare from the lamp.

MIRRORS FOR REFLECTING HEAT.

THE following notes were contributed by Professor Chas. Féry, of the Ecole Municipale de Physique et de Chimie, Paris, to a discussion on the "Making of Reflecting Surfaces," which was arranged by the Physical Society of London and the Optical Society, and held at the Imperial College on November 26th, 1920. All the papers have now been published in a collected form at 5s.

Some metals, such as gold and silver, take a fine polish and reflect 98 to 99 per cent. of the heat radiation falling upon them. For this reason they have been largely used in a certain number of instruments, particularly in radiation pyrometers, the action of which is based on Stefan's law. Silver, unfortunately, dulls quickly in air, and the same effect occurs—although in a lesser degree—with the old bronze alloy (speculum metal) from which the mirrors of astronomical telescopes were made.

An endeavour was made to electro-plate bronze mirrors with a thin coating of gold, but this process, which should have given good results, was abandoned. It was found very difficult to obtain a thin coating of gold without any break in the continuity of the surface. If only one spot of the metal was not covered by gold, this spot became an electric cell, and under the influence of humidity and fumes which are found in works where pyrometers are used, the bronze was attacked sooner than if it were not covered with gold. It was found that a spot was formed which became larger and larger, and thus gradually reduced the amount of radiation reflected by the mirror. It was then proposed to use silver again, which deposits easily on glass mirrors, and these are lighter and easier to polish and to make than metal mirrors. To avoid the oxidation and sulphuration of the metal, it is sufficient to cover the silvered surface with a varnish which does not absorb the heat radiations. It is known that all bodies which contain oxygen have low diathermancy, and that on the other hand the hydrocarbons are very transparent. Judee's bitumen, which is a natural hydrocarbon, can be made into an excellent varnish which possesses the advantage of hardening under the influence of light. This property has caused it to be used in photogravure, for, as is well known in that process, it resists the action of nitric acid used for etching the zinc. The experiment has proved that this varnish prepared with a suitable absorbent (benzine is too volatile) gives a very regular and thin coat which absorbs only 3 per cent. of the total radiation reflected by the silver. The colour of the mirrors which are thus treated is almost identical with that of gold, and the mirrors do not show any selective absorption in the infra-red. The varnish appears to be extremely hard, and the mirrors may even be dipped into ammonium sulphide without suffering. They can be cleansed by washing, without difficulty. Their price is less than that of any other mirrors that are intended for the same purpose.

Note by Editor of Physical Society "Transactions."—Judee bitumen varnish may be obtained from M. Detourbe, 7, Rue St. Severin, Paris (London House, 79, Coleman-street, E.C.), under the name of "Vernis à recouvrir." It appears to be a solution of bitumen in French turpentine. French turpentine does not seem to be readily obtainable in this country, but either American spirits of turpentine or commercial pseudo-cumene (or pseudo-cumol) may be employed as solvents for bitumen. Powdered Judee bitumen may be obtained from Billault Chenal, Douilbret and Cie. Succrs., 22, Rue de la Sorbonne, Paris. Pseudo-cumene may be obtained from Messrs. Harrington Bros., Oliver's-yard, City-road, London. The varnish made with pseudo-cumene is a little more transparent and of a slightly better surface. It has also the possible advantage that the pseudo-cumene is entirely volatile. With turpentine there is always the chance of some change during oxidation of the solvent.

City and South London Railway—Tunnel Enlargement.

One of the most interesting works from the engineering standpoint included in the improvement plans put forward by Lord Ashfield for the London Underground Railways is the enlargement of the tunnels of the City and South London Railway.

This line, it may be recalled, was the first of the London tube railways to be driven. It was incorporated as the City of London and Southwark Subway in the year 1884 to construct two tunnels passing under the Thames from King William-street to the Elephant and Castle. In the year 1887 powers to extend the railway to Stockwell were obtained, and further extensions southward to Clapham and northwards to Islington and Euston were afterwards authorised. In the year 1900 the first section of the line between the City and the Elephant and Castle was opened for traffic. An extension to Moorgate was put into service in the year 1900, in which year also the extension to Clapham was made available. The northern extension to the Angel, Islington, was opened in 1901, and that to Euston in the year 1907. The route mileage of the line is 7 miles 26 chains, and the track mileage, including sidings, 15 miles 54 chains. It and the Waterloo and City are the only existing tube railways which are underground from end to end. By the scheme now proposed the existing tunnels will not only be enlarged from the original diameter of 10ft. 6in. to an internal diameter of 11ft. 8½in., but the line will be linked up with the Hampstead and Highgate Railway by a short extension from the Euston terminus, the point fixed upon for making the junction being near Camden Town Station. The decision to enlarge the tunnels to the diameter of the other tube railways so that through services can be put in operation when the Camden Town link with the Hampstead line is completed, was made in the pre-war period, and powers were granted for the work in the year 1913.

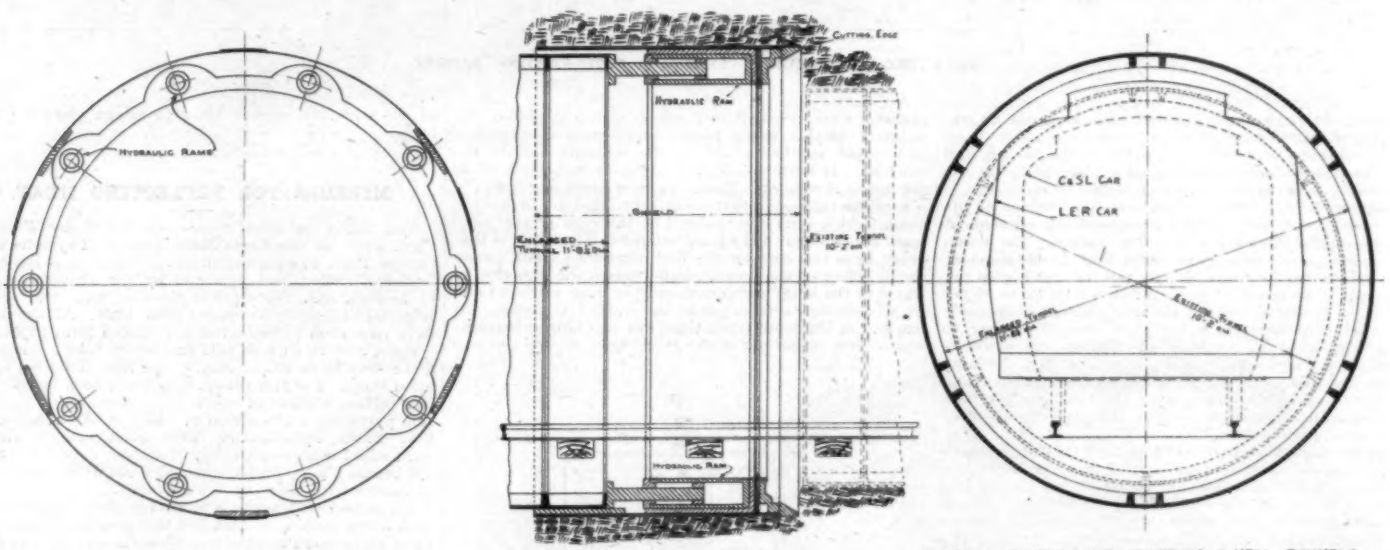
The accompanying drawings will indicate the method by which the enlargement of the tunnels is to be effected without hindrance to traffic. The existing tunnels are of the character which the Underground Railways have made familiar. The inside lining, as is well known, consists of a series of rings of cast iron segments united by bolts and nuts, each ring being also bolted to that adjoining it on either side. Each ring of the present lining is made up of six segments and a key, and it is intended to use all these parts again in the larger tunnel with the intermediate small supplemental segments indicated on the drawing above.

An experimental length of about 200 yards has been carried out near Stockwell Station in order to test the proposed method of construction and to ascertain by actual experience how best to overcome the difficulties which it was foreseen would be encountered. The work at Stockwell has shown that the proposed method is likely to prove quite successful both as to the time which the work is likely to occupy and the cost of the operations. Use will be made in the enlargement, which will be carried out simultaneously from a number of different points, of specially designed Greathead shields, which it is necessary should remain in position and yet permit of trains passing through them during traffic hours. Each shield will be furnished with ten hydraulic rams capable of exerting a total pressure of about 400 tons.

When the shield is ready to advance, a ring of the present lining, segment by segment, will be taken down in front of the cutting edge and carried back to the rear of the shield, where it will be cleaned and made ready for re-erection. The pressure will be then turned on to the rams and the shield advanced, cutting out the excavation to the exact diameter required. The length of a ring of lining in this case will be 20in., and as soon as the shield has travelled forward that distance the enlarged ring will be built up inside the tail of the shield as shown on the section. As the shield continues to advance the small annular space left outside the lining will, in consonance with usual practice, be filled up with grouting, to prevent subsidence and consequent damage to buildings, &c., overhead.

In order to carry out the work it will, of course, be necessary to remove each night a short length of the permanent way and electric conductors. This will be done immediately the traffic ceases for the day, and will be replaced in time for the resumption of the morning traffic. Under normal traffic conditions about four hours' clear working time will be obtained each night, and experience at Stockwell has shown that two rings, equal to a length of 3ft. 4in., could be erected complete in that time. It is probable that as the work progresses the traffic night and morning may be curtailed to facilitate progress, and it is expected that by working at a large number of places simultaneously the whole of the smaller tunnels will be enlarged in about twelve months. It will probably take another twelve months to make the necessary alterations to the stations and relay the permanent way with the standard bull-headed rails, &c., used in other tube railways. It is understood that the specifications are all ready for the work to begin and that delivery of the new segments could be made within two weeks of the order to commence operations.

The reconstruction of the line will increase its carrying capacity by at least 100 per cent. Its operation by standard modern rolling stock will enable the speed of the services to be materially increased, and the Bank will be brought within twelve miuntes of Clapham Common. The junction of this tube with the Hampstead line, when the latter is extended, will enable through journeys to be made from Clapham Common through the heart of the City to Hendon and Edgware. On the other hand, fast and frequent electric train services from the districts of Edgware, Colindale, and Hendon will make a valuable new link with the City. Edgware will be brought within half an hour's run of the centre of the City, and the intervening stations correspondingly less. The end-to-end journey from Edgware to Clapham Common will be completed within three-quarters of an hour. From Golders Green it will be possible to reach Moorgate without changing cars in twenty minutes, as against twenty-eight to thirty now, a gain of at least sixteen minutes on a double daily journey. Incidentally, it may be remarked that the extension of the Hampstead line from the present terminus at Golders Green for a distance of five miles to Edgware will be a surface railway except for a tunnel about a quarter of a mile in length near Hendon. Eight steel bridges and several viaducts are included in the plans for this work, which should be completed within a period of eighteen months.


Hydraulic Rams
Cutting Edge
Hydraulic Ram
C & S L Car
L & E R Car
— Elevation of Shield —
— Longitudinal Section —
— Scale —
Inches 12 0 1 2 3 4 5 6 7 8 9 10 Feet
— Cross Section of Existing & New Tunnels —
"The Engineer"
Swain Sc.

Arrangements for Enlargement of City and South London Railway Tube

Institution of Electrical Engineers.

On Monday, November 7th, an informal meeting of the Institution of Electrical Engineers was held at the Institution's headquarters, when Mr. J. S. Highfield, the new President, occupied the chair. The meeting was devoted to a discussion on "How Best to Speed Up Electrical Progress," and the discussion was opened by the President. Electrical progress, he said, might be taken to represent a condition under which everyone who wanted a job could obtain one. To reach that condition, however, it was necessary to get electrical services appreciated. If electrical engineers took care to see that the demand for electricity all over the country was fostered by good service and honest efforts to cheapen supply, there was, he thought, a wave of prosperity just ahead of us. It was desirable that customers should be induced to extend the use of small apparatus, such as electric irons and toasters, all of which might be supplied through existing house wiring and a single meter, the charge for the current being made on the two-part tariff system.

Mr. E. T. Williams advocated more advertisement, and argued that the supply authorities might bring their wares to the notice of the public by means of the cinema.

Major T. Rich emphasised the need for making everything as simple as possible.

Mr. W. L. Wroford referred to the regulations of some supply corporations. Many of their restrictions, he stated, were ridiculous, and were without any legal authority. It was desirable that an abriged edition of the wiring rules and regulations should be issued, and that it should give a digest of the authorised conditions in connection with electricity supply.

Mr. W. Dargavall thought that technical language should be avoided in transactions with the layman. Electrical apparatus should be marked with terms which could be understood. Why not, he asked, retain the familiar "unit" rating of house meters, instead of changing to kilowatt-hours, as required by the Board of Trade?

Mr. W. E. Warrilow thought that electrical engineers ought not to preach to the layman until they themselves were good consumers of electricity. He wondered how many present at the meeting used electricity for lighting, heating and cooking.

The President declared, however, that he had used electric cooking for twenty-five years, and in spite of discouragement and defects, his household felt that it was far ahead of any other system of cooking.

Mr. Pooley said that the answer to the question which the title of the discussion raised was briefly, Remove legislative and executive restrictions by which the industry is shackled. It was the duty of the young men in the industry to carry on a campaign with that object in view.

Other speakers who took part in the discussion were Messrs. P. S. Fox, M. Farrer, G. L. Addenbrooke, A. B. Eason, W. G. Johnson, W. C. Rogers, A. D. Chamon, J. R. Bedford, and W. C. Kennett.

Canadian Mining.

According to a report recently made by the Trade Commissioner in Winnipeg to the Department of Overseas Trade, the output of coal from Canadian mines during the first six months of this year was only 86 per cent. of that for last year, the figures given being 6,783,060 tons, as against 7,929,269 in 1920. The output in Saskatchewan, British Columbia, and Alberta was respectively 94 per cent., 91 per cent., and 79 per cent. of last year's production. For the same period the total exports of Canadian coal amounted to 869,004 tons, of which 517,823 tons were shipped from British Columbia.

The total value of mineral production of British Columbia for 1920 has been estimated by the Minister of Mines at 5,543,084 dollars, 2,000,000 dollars more than in 1919. The value in dollars of the minerals produced were as follows:—Placer gold, 221,600; lode gold, 2,481,392; silver, 3,325,980; copper, 7,832,899; lead, 2,816,115; zinc, 3,079,979; coal, 12,975,625.

It is anticipated that this year the gold output will be considerably in excess of that of last year, and it is conservatively estimated to exceed 3,500,000 dollars in value. Silver mining in Northern British Columbia and the Yukon is flourishing, and several new properties are being developed, mostly with American capital.

A valuable deposit of asbestos has been discovered at Sidmouth, not far from Kamloops, B.C. The vein, which is stated to be from 300ft. to 500ft. wide, shows fibres of 3in. or 4in. in length of asbestos, suitable for weaving into cloth. The deposit is reported to be similar to that found in Quebec.

400-H.P. Wood Refuse Suction Gas Engine.

THE largest engine which has up till now been built by Fielding and Platt, Limited, of Gloucester, to work on gas derived from a producer fired with wood refuse is illustrated on page 540. The engine has four cylinders, each 17in. in diameter by 24in. stroke, and it is designed to develop a maximum of 400 horse-power when running at a speed of 190 revolutions per minute. It is at work in the match factory at Gloucester of S. J. Moreland and Sons, Limited, and it is coupled direct to a Mather and Platt electric generator of 250 kilowatts capacity. We are informed that ever since the engine has been installed it has operated with great regularity, there never having been any occasion to shut down in consequence of defect. The gas plant, which was supplied by Ruston and Hornsby, Limited, of Lincoln, has also worked without any hitch in spite of the difficult nature of the fuel employed, which consists of waste matches, boxes, chippings, and wood refuse generally.

The general features of the engine are well shown in the illustrations. The engine bed is made up of two castings bolted and keyed together, and each combining the cylinder jackets and the housing for the main bearings of the crank shaft, the design being such that the cylinders are supported throughout their whole length, and that, consequently, there is no overhang. The pistons are of cast iron, and are fitted with spring rings. The combustion chambers are made in one casting, which also carries the valves. They are provided with independent water jackets so as to avoid the necessity of having a water joint between the cylinder and the back end, the construction also enabling the temperature to be regulated independently of the cylinder jackets. The joint between the combustion chamber and the cylinder is, the makers assert, so completely protected from the explosion as to be practically indestructible.

The engine is fitted with the "Fielding" variable admission governor, which controls the opening of the gas and air-mixing valve, thereby varying the volume of charge admitted to the cylinder according to the load on the engine. The stroke of the mixing valve is directly under the control of the governor, and although the volume of the charge is varied, the ratio of gas and air in the mixture remains, it is claimed, practically constant. The governor itself is of the rotary ball type, and it is furnished throughout with ball bearings. The valves are of the mitre type. The exhaust valve is fitted with a renewable guide, which is lubricated by an external lubricator. The valves are opened by levers, which are actuated by machine-cut cams keyed on the half-time shaft. The cam shaft is driven off the crank shaft by skew gears. The main inlet valve is placed on the centre line immediately above the exhaust valve, a construction which has the effect of shortening the overhang of the combustion chamber. All the valves are easily accessible for cleaning and grinding, and, by removing the main inlet valve, the whole back end as well as the piston head can be cleansed without having to dismantle either of them. As a matter of fact, however, we understand that the gas is so well cleaned that after three months' working there was hardly sufficient dirt on the gas valves to necessitate taking them out for cleaning purposes. We are informed by Messrs. Moreland that a remarkable feature of the installation is the steady running of the engine and the absence of noise when working, the operation, according to them, being equal to that of a high-class steam engine.

The ignition is of the low-tension semi-rotary type, the mechanism being actuated by a simple arrangement driven off the cam shaft. Each cylinder is independently fired by a separate magneto, and the points of ignition may be varied at will while the engine is running. The sparking plugs, which are insulated with pure mica, can be removed by simply loosening two nuts. Each plug provides duplicate ignition. The engine is started by means of a small air compressor, the compressed air being admitted to two of the cylinders only. The working air pressure is 150 lb. per square inch.

The gas engine cylinders and pistons are lubricated by means of a positive pressure feed adjustable lubricator, the pump of which is driven off the cam shaft. The main crank shaft bearings are fitted with oil wells and oil rings, oil being supplied continuously in addition by a pump driven by the engine shaft. The crank pin is lubricated by centrifugal force from oil rings in duplicate, the oil being supplied by an adjustable sight-feed lubricator. There are, in fact, two complete systems of lubrication which are entirely independent of one another.

Of the engine generally, it may be said that there is an oil tray cast round the bed for the purpose of collecting any oil overflowing from the bearings and preventing it from being lost or from reaching the foundations. There is a heavy fly-wheel 8ft. 6in. in diameter and 20in. wide on the face, which is supported by an out-board bearing. The crank shaft, which is of forged Siemens-Martin steel, is in two parts. The cranks are cut out of the solid forging, and the crank webs are each fitted with balance weights secured by steel bolts. The connecting-rod is forged solid in one piece, and has marine type bearings. The main crank shaft and connecting-rod bearings are lined with white metal, while the gudgeon bearings are of gun-metal, all the bearings being adjustable for wear. As will be observed, the crank shaft and cranks are well covered in with splash guards. The oil escaping from the various bearings is collected in the engine bed, from which it is drawn, filtered and used again.

The type of gas producer employed and a diagrammatic sketch of the arrangement of the gas plant are shown in the accompanying illustrations. The gas generator is built of thick steel plates and is lined with fire-bricks and packing, doors being provided in the casing for the purpose of cleaning the fire. The fire-bars are loose and can be removed and replaced through the fire-doors. The fuel chamber is made specially large so as to obviate the necessity for frequent charging. The fuel is fed direct into the top of the fuel chamber, but there are no hopper, valve or slide, they not being necessary for wood fuel. There are poking holes in various places, so arranged that any part of the furnace can be reached with pokers and the fire consolidated. Instead of the gas leaving the generator by a single outlet, it is drawn off at four points at the top by vertical pipes which lead in pairs into gas mains sloping down towards the dust collectors. The reason for having multiple outlets is that there may be an even draught through the fuel beds at all points and at all loads. The gas pipes which come from the producer, and those which lead to the dust collectors, are furnished with reciprocating scraper rods by which tar and dust deposits can be removed at any time without interfering with the production and supply of gas. From the dust collectors the gas passes to a two-stage rotary tar extractor, where the tarry matters are removed and from which it passes to a sawdust scrubber before being taken to the engine. The scrubber, which also forms an expansion chamber, is fitted with a series of sieve-like trays containing sawdust. In the dust collectors the gas first passes down side tubes and then up through a central chamber, where it is cooled by water spray. In them the dust and a large proportion of the tar are deposited in a water seal at the base and can be removed while the plant is in operation. How well the cleaning is effected may be gauged by what has been already said concerning the working of the engine. We understand that in these waste wood gas producers from 6 to 8 gallons of water per brake horse-power per hour are required for cleaning the gas. Most of this water can be used many times by the employment of a filter, sump and circulating pump, but it is stated that there should always be available at least 1 gallon per brake horse-power-hour of fresh, clean, cool water.

In connection with the foregoing Messrs. Moreland have courteously furnished us with the following interesting notes concerning their waste-wood power plant generally:

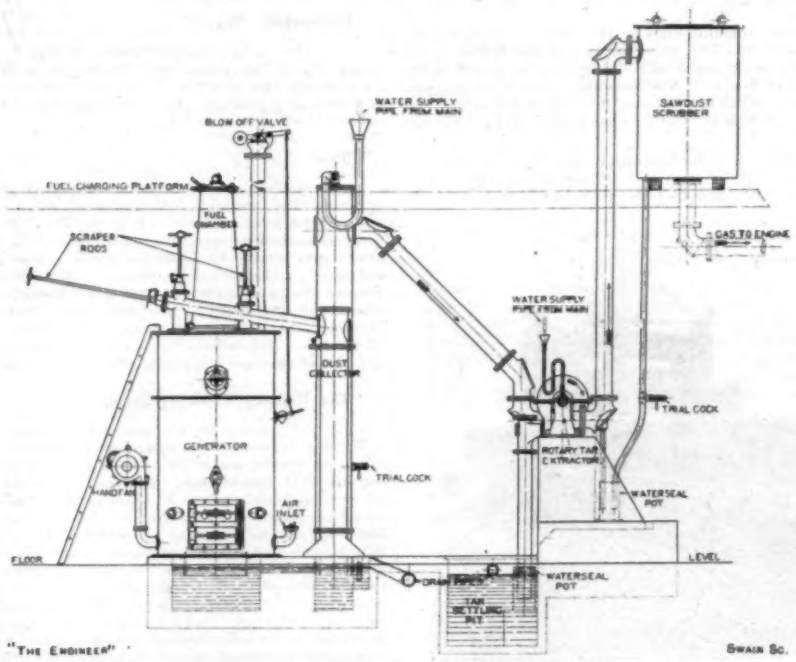
Previous to 1918, when the present plant was installed, power was obtained from thirteen steam engines, each situated in and driving by belt a separate department, steam being supplied by three 30ft. Lancashire boilers. This arrangement of plant was the result of the gradual development of the factory, an engine being added as the necessity arose for more power—a practice still to be found in many of the older manufacturing concerns to-day. The whole plant was most uneconomical and unreliable and the cost of maintenance high. The consumption of fuel amounted to about 80 tons of best steam coal per week, together with all the wood refuse—approximately 30 to 40 tons per week. It was therefore decided to erect a central power-house and to install a gas-driven electric plant. The necessary alterations were carried out by the firm's own staff, without interfering with the running of the factory in any way. The steam engines were subsequently scrapped, though two boilers were retained for heating purposes only, and they are now consuming some 8 tons of coke breeze per week. The whole of the power required for the factory is, therefore, being now derived from wood waste alone, the refuse consisting of waste splints, boxes, sawdust, shaving, &c. Apart from other considerations, therefore, there is a direct saving of 80 tons of steam coal per week.

The present power plant is housed in a building measuring 80ft. by 60ft., which is centrally situated in the works. It consists of three Ruston and Hornsby 275 horse-power wood refuse suction gas plants, supplying gas to two Crossley 250 horse-power twin-coupled gas engines, driving by belt two 170-kilowatt dynamos as well as to the Fielding and Platt-Mather and Platt set described above, which is the latest addition to the plant. There is also a 60-kilowatt high-speed steam set, but it is only used in emergency, either for lighting or driving the air compressors which are employed for starting the gas engines. All the dynamos are run in parallel, the voltage of supply being 220, both for power and lighting.

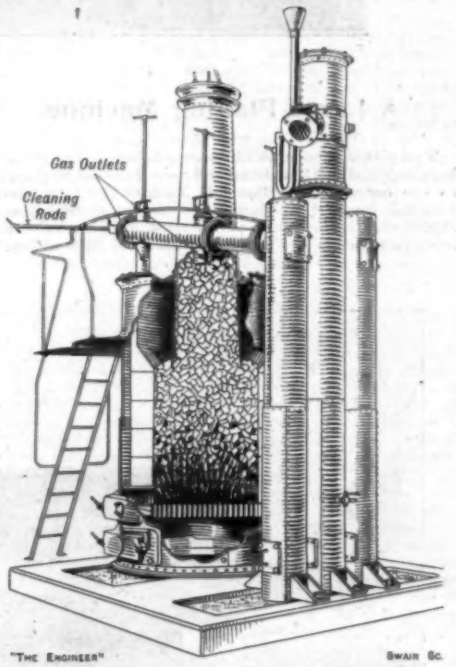
The fuel is collected from the various machines working in the factory and conveyed to the gas plant house, where it is elevated by means of a bucket conveyor to the charging platform. The quantity at present being consumed is approximately 5 to 6 tons per day of eleven hours, the average load during the summer months being about 350 horse-power. Taking 5.5 tons as the average daily consumption, the consumption of wood refuse per horse-power-hour with that average load works out to exactly 3.2 lb. The load is, however, considerably increased by the lighting and electric heaters during the winter months. It is found that when consuming from 5 to 6 tons of fuel per day there is a yield of from three to four barrels of tar per week, but it is of low commercial value. There is also a large percentage of acetic acid in the scrubber cooling water, and it is proposed to install apparatus to recover that substance at some future date.

The cooling of the gas engines is carried out by means of a 3000-gallon water tank which is situated above the power-house and supplies the engines by gravity. After leaving the jackets the water flows to a sump and is again lifted to the overhead tank by means of two motor-driven centrifugal pumps. The tar extractors are also driven by electric motors, and for blowing up the producers water motors are fitted to the fans. The whole operation of starting and working of the plant is extremely simple and but three men are required to be in attendance.

Apart from the great economy of the plant, many other advantages have been gained as the result of installing it. There is, for example, better control over the machinery necessary for the process of match-making both in speed and regularity of output. This remark particularly applies to the four-cylinder engine, the regularity of working of the gas plant having been considerably improved by its installation.



DIAGRAMMATIC SKETCH OF RUSTON-HORNSBY WOOD REFUSE SUCTION GAS PLANT

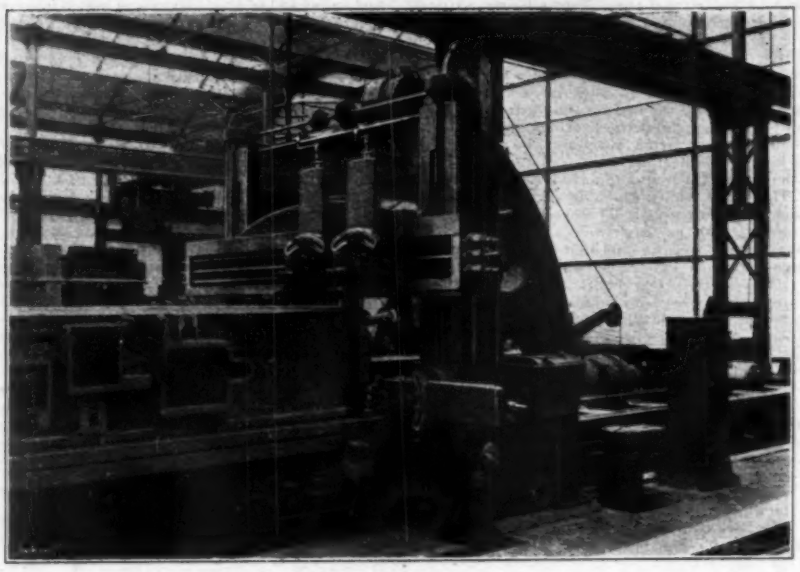


RUSTON-HORNSBY WOOD REFUSE GAS PRODUCER

THE Institution of Railway Signal Engineers has just established a northern section for members in Lancashire, Yorkshire, the North of England and Scotland. The secretary is Mr. Charles Carslake, assistant signal superintendent, Great Central Railway, Guide Bridge, and the meetings will take place at York and Manchester alternately. The opening meeting was held at York on the 28th ultimo, when a paper by Mr. W. S. Roberts on "Recent Developments in the Token System for Single Lines of Railway" was read.

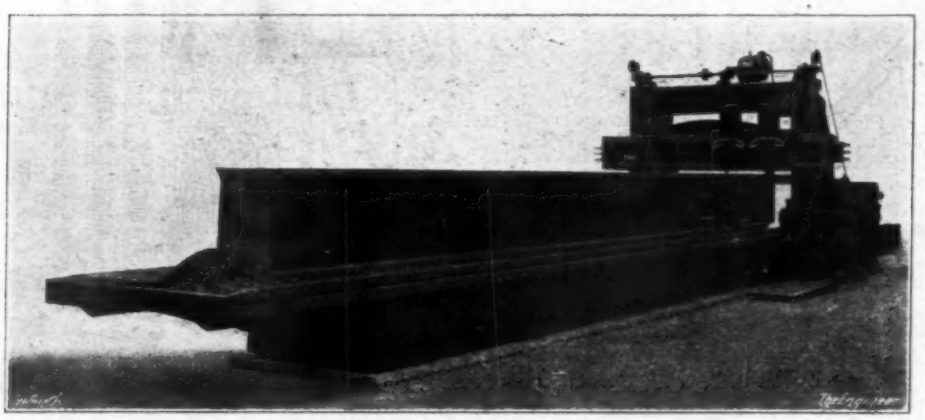
35-FOOT PLANING MACHINE

C. REDMAN AND SONS, LTD., HALIFAX, ENGINEERS



A Large Planing Machine.

THE planing machine illustrated herewith has recently been supplied by C. Redman and Sons, Limited, of Halifax, to the order of the Churchill Machine Tool Company, Limited, for that company's new works at Broadheath, Manchester. The machine has been designed to accommodate work up to 6ft. 6in. in width and 35ft. in length.



PLANING THE BED OF A LARGE GRINDING MACHINE

Its bed has a total length of 58ft. and is formed in two lengths, which are bolted and keyed together. The table is also formed in two lengths, each 17ft. 6in. long by 5ft. 6in. wide, and is fitted with gib strips to prevent its lifting when a heavy cut is being started. The gear wheels in the bed and the rack on the table are made of cast steel machined from the solid, with the exception of the first motion pinion, which, with the object of securing quietness of running, is formed of Ferodo. The four tool-boxes with which the machine is equipped are each provided with automatic feeds in both directions. A micrometer adjustment is fitted to the screws of the down slides to enable the operator to work to a given depth of cut accurately and quickly. To raise or lower the cross slide a reversible motor is fixed at the centre of the cross rail, the arrangement being such that any torsional strain in the operating shaft is evenly distributed.

The machine is driven by means of a "Lancashire" patented electric drive embodying a 40 horse-power variable-speed motor. By means of this drive cutting speeds varying, in eighteen stages, between 22½ft. and 90ft. per minute are obtained. The return speeds range between 80ft. and 150ft. per minute. At the rear of the table an accelerating switch is fitted to enable the table during the cutting stroke to be speeded up to the value of the return speed when two or more surfaces some distance apart are being planed. The device thus results in time being saved while the gap between the faces is being traversed. In addition, the accelerating switch can be used to increase the speed after the tool has entered the cut or to reduce it just before the tool leaves the work, the object being in the one case to reduce the shock on the tool point, and in the other to diminish the likelihood of the edges of a casting being broken off during the last portion of the cut. The switch is electrically conpected to the speed regulators on the main control panel and is operated by adjustable tappets fixed to the edge of the table. On the return stroke the tappets glide inoperatively over the switch levers.

In our engravings the machine is shown at work on the bed of a large Churchill grinding machine, the table of which was also planed on the machine. On both the roughing and finishing cuts in the case of the table the cutting speed was 35ft. per minute and the return speed 84ft. The average depth of the roughing cut was 0.875in. with a feed of 0.031in. For finishing a broad cutting tool was used, the depth of cut being 0.031in. and the width of the traverse 0.625in. The finished weight of the table was 14 tons 7 cwt.

The lubrication of the bearings in the machine is effected from a reservoir by way of fourteen independent sight-feed drips neatly grouped together and attached to one of the standards. The net weight of the machine as finished is 42 tons.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Drop in Midland Crown Bars.

MAKERS of unmarked bars are feeling the competition of steel, so far as they can be said to feel anything in a market which is almost inanimate. Some makers of iron bars have shut down their plants altogether; others are rolling intermittently. Two days' work a week is probably above the average for South Staffordshire mills. Prices are falling and competition is keener than ever in the ironworks. Some of the associated firms still demand the £14 10s. fixed upon as the standard for ordinary wrought iron, but some makers are quoting as low as £13 10s., and some contracts are said to have been made at as low a figure as £13 5s. The firms quoting lowest prices are among the most active of the works in the district. They are for the most part non-associated firms, and they are stated not only to be willing to accept business at these low prices, but also to be willing to forego extras on special sizes. Belgian bars can be bought at about £10 5s., freight included, and steel bars rolled from lowest-priced billets are obtainable at £11, or something less. It may be inferred, therefore, that the amount of business which is passing in iron bars at £14 is negligible. The nut and bolt makers are very badly off for orders. Those works which are operating are running only two days, or in some cases three half-days, a week, and no sign of improvement can be discerned. The marked bar houses continue fairly busy, orders being accepted on the basis of £17 10s. Ironmasters are getting a little advantage from cheaper coal which, for the forge and mill furnaces is now obtainable at 23s. 6d. There is a fair amount of business being done in galvanised sheets, but mills could handle a good deal more without stretching their resources. Quotations range upwards from £18 10s. f.o.b. The trade will be assisted by the further reduction in Welsh steel, making the price for steel bars £7 15s.

Further Drop in Pig Iron.

Values of pig iron are still decreasing. Northamptonshire forge can be bought at £4 17s. 6d. at the furnaces, and Derbyshire at £5 f.o.t. But in both districts an attractive order would include a shading of these prices; though as consumers buy strictly to meet immediate needs, orders seldom exceed a few hundred tons. A noteworthy circumstance, however, is that orders are invariably followed by keen pressure for delivery, consumers having exhausted all the iron in stock. Derbyshire No. 3 could be bought on Birmingham Exchange on Thursday down to 105s., a drop of 5s. on the week, the minimum in the case of Northamptonshire being about 2s. 6d. below that figure. There was only a very slow market. Consumers are carrying on with the smallest possible margin, expectations of greater activity in the foundries having been disappointed. The difference between British and foreign pig iron prices is now so trifling as to offer no practical advantage to the buyer. There are strong complaints of unprofitable production, one large firm estimating its losses at £1 10s. per ton of pig iron. The business at the foundries is a little better than it was, and is expected to give a stimulus to the demand for foundry iron, especially for the supply of certain requisites for motor construction, which is showing a little revival. It was reported that so far from getting any concession on their coke, furnace owners were being asked to pay more. One case may be instanced in which 26s. 6d. was quoted for coke which could have been bought at 22s. 6d. a month ago. This is attributed to local and temporary influences.

Ironworkers' Wages.

The price ascertainment under the Midland Wages Board for August and September is now due for publication, and is expected to carry an immediate fall in ironworkers' wages. It is believed that a fairly large reduction will be declared.

Steel.

Steelmakers are keenly competing for business, although they complain that in some cases the present selling price involves a loss of £2 per ton. Foreign competition in steel has nearly ceased, continental firms being busier and unable to make deliveries, while their prices are usually as high as those quoted for British steel. Some Belgian No. 3 iron for nut and bolt making is, however, offered here at about £9 10s. delivered. Steel scrap has become very cheap, quantities having been sold under £2 per ton. But railway rates also enter into this matter, the cost of carriage frequently amounting to £1 per ton.

The Railway Rates Agitation.

The agitation for reduced railway rates gains strength. Simultaneous action with this object is being taken by several associations, such as scrap dealers, both ferrous and non-ferrous, merchants' associations, &c., while such bodies as the Federation of British Industries and the National Federation of Iron and Steel Manufacturers are all pressing the railway companies. One South Staffordshire furnace owner in the Wolverhampton district recently submitted figures showing that the present rate, after the recent slight reduction for carriage of iron ore and limestone is, for the former, 87 per cent. above pre-war rate, and for the latter 73 per cent. This district is badly handicapped, because of the long distance which raw materials have to be conveyed to the furnaces, and it is intended to keep several Staffordshire furnaces idle until a substantial reduction is made in railway charges. General expression is being given to the view that the railway companies should not be entitled to meet the claims of the trading community with the argument that the companies' revenue will not stand reduction in the present abnormal level of rates and charges. The point of view of Midland manufacturers is that every other commercial concern is being compelled to cut down expenses in order to meet the needs of the present situation, and it is felt that the railway companies should not be sheltered from a similar necessity at the expense of the trading community.

Machine Tools and Government Sales.

Protest is being made by machine tool engineering firms in the Birmingham district against the casting on an already over-gorged market of tens of thousands of machine tools which the Disposals Board has received as a legacy from the war. The vague statement that "good prices are being obtained" may satisfy the official conscience, but it does not square with trade ideas of value. It is beyond question that many of these surplus tools have been knocked down at absurdly low prices. Latterly a large proportion of them have gone into the hands of dealers, who think them worth holding against future demand. The probability is that they will remain an obstacle to revival in the machine tool trade for a long time to come. The plight of the industry has been brought to public notice this week by a question in Parliament. In suggesting, as Mr. Neville Chamberlain's question did, that unemployment in this branch of industry is being made very much worse by the throwing on the market of surplus war stocks, it gave expression to a sense of grievance which prevails amongst the makers of machine tools. The large proportion of skilled labour which goes to the making of a machine tool is an important consideration just now, and it is on this aspect of the case that the protest is chiefly based. I might be permitted to review in brief the circumstances which have led up to the present *impasse* in this important Midland industry. During the war the production of machine tools was practically nationalised, as were other industries, when the Ministry of Munitions took command. When the period of reconstruction was entered upon, manufacturers discarded vast numbers of tools as being of no use to them

in the peace-time pursuits to which they were devoting themselves. This restricted the opportunities of machinists for getting rid of the stocks which had been left on their hands. When the slump came in sight there was practically no department of manufacturing industry which had not more plant than it knew what to do with. In not a few cases the burden could not be carried, and there were forced sales of machinery. The state of finance in markets abroad precluded any appreciable extension of trade outside the kingdom, and so the machinists' occupation was gone, except for occasional orders for special types of tools. To-day what call there is for tools is being, it is stated, met by the Government's surplus stock, and the machine tool industry remains stagnant. One Birmingham manufacturer suggests, seriously, that the best way out of the present difficult situation would be to break up these surplus tools and for the Government to be prepared to sell them as scrap. In the present state of the Exchequer counsel of that sort is hardly likely to gain acceptance. Another suggested way out is for the makers greatly to reduce their prices, but until there is the prospect of such a demand as will enable tools to be produced on more advantageous terms proposals to lower selling prices are not regarded by Midland engineers as a very hopeful way out of the *impasse*.

Birmingham Brass Trade Improvement.

The brass trade, which has been very badly off for business for some time past, now shows signs of improvement, especially in the export branch. Substantial orders for water fittings have lately been given out, and Australia and New Zealand are purchasing water fittings, gas fittings and other brass goods. The endeavours which these countries have made to become self-supporting have not succeeded so far as to make them independent of the Mother Country. Few firms have sufficient orders to keep them fully occupied, and there are large stocks at most of the factories. There has been a considerable liquidation of merchants' and retailers' stocks, but buying in the home market at any rate is strictly proportioned to current demand. There is a general impression that prices will go lower, and this is affecting the size of orders given out.

Trade Improvement in the Black Country.

I am happy to be able this week to report that a slight improvement in trade is noticeable in most parts of the Black Country, many firms having considerably increased the number of men in their employ. Some parts of works which have been standing for twelve or eighteen months are being brought into use again. In the Halesowen and Rowley Regis districts considerable activity is being shown in the engineering industry, and one firm has not only increased to a large extent the number of men on day shift, but has introduced a night shift for the first time since the cessation of hostilities in November, 1918.

Coventry's Unemployed.

There is a slight improvement in the trade position in Coventry, and it is hoped that the motor industry will brighten considerably as a result of the Show. Indeed, in several instances the business transacted is stated to have exceeded anticipations. The foundries are doing little, if anything, at present, but they are more hopeful than they have been for some months past. The latest unemployment returns, unfortunately, show an increase of over 400 in the number of persons entirely without work, but the number of short-time workers shows a slight decrease.

Wages in the Ships' Tackle Trade.

The ships' tackle and oddworkers in the Cradley Heath and Old Hill districts have agreed to accept a reduction of 7½ per cent. in wages. The employers proposed a reduction of 17½ per cent., but they eventually consented to the wages being regulated by the cost of living until the price of food fell to 100 per cent. over the pre-war level. Under these circumstances, as the wages were 117½ per cent. higher than in 1914 and the cost of living 110 per cent., the operatives accepted a reduction as stated above.

LANCASHIRE.

(*From our own Correspondents.*)

MANCHESTER, Thursday.

Iron, Steel and Metals.

THERE are various reports about to the effect that business is getting a little better in the iron and metal markets, but when one tries to trace them to something tangible, they are very elusive. Of course, there are a good many people now who wish things to be better, and the wish may be father to the thought. The state of trade and the lack of all confidence amongst buyers has led to an almost total suspension of the "bear" business in iron and metals, which used to play so important a part in the markets, and perhaps it is this circumstance which leads to an increase in the number of people who wish for rising markets. It is as well, however, to remember that better trade does not come merely because people wish for it, and so far as can be seen, little has yet been done to remove the causes of stagnation, even if we knew what they all were. If the peace of the world is assured by the proceedings at the Washington Conference, one cause will be removed.

Metals.

The market for copper remains very flat, and the changes have been quite unimportant. The margin between standard and electrolytic copper widened a little last week, but the price of best selected copper keeps unnaturally close to that of standard, and shows how poor is the consumptive demand. The Government Disposals Board has now sold the balance of the stocks of copper, some 9000 tons, and this is so far satisfactory; but the taxpayer will be asking why this copper was retained for three years after the war was ended. If the reason be that it was held for a good price, one can judge of the wisdom of allowing Government officials to speculate, for there was a time last year when copper was nearly £60 per ton dearer than it is now. The actual demand for copper in the engineering district is very much restricted, and merchants appear to be more gloomy about the outlook than they were. The writer's feeling about markets is that when everybody is convinced that there is no hope, then is the time to buy for stock; but, of course, this feeling is not always justified by events. In America there is a rather stronger tone in the copper market, based upon the fact that production is down to a minimum, and that there are many works which cannot start again until the price reaches 15 cents at least. There has been no further change in the manufactured copper and brass prices, and the recent reduction does not do much to bring them into proper relationship with raw metals. There is an improved feeling in the market for tin, and the volume of buying seems to be larger. America is doing a little and the Continent rather more. Eastern tin is being sold more freely, and it is now generally believed that there is a chance of a rise, for the present prices are far from being extravagant. The tin-plate trade shows some sign of better times to come, and may be expected to consume more tin. The market for lead remains very firm, and with an upward tendency, while at the same time the business being done is quite small. Consumption here is certainly not good at present, but there seem to be expectations of an improvement in the demand from the cable trade. Whether any house-building demand can be hoped for seems doubtful. The local stocks are small and the market is well controlled, so that one cannot expect any serious break in prices at present. In spelter there is practically no change. The market is said to be rather quieter, but, if so, one cannot see the effect reflected in the prices. People are still in the dark as to what is to happen regarding Silesian spelter, and Germany does not yet offer any metal.

Pig Iron.

The trade in forge pig iron in this district seems almost dead. Probably some little business is being done direct between the furnaces and the Lancashire iron rolling mills, but it does not seem to come through Manchester. In foundry iron there is, of course, a little trade always going on, but it is now mainly of a retail character, and one cannot get any definite information as to the lowest prices which would be accepted for a good contract. Small orders are placed, but at prices ranging from £5 15s. to £6 delivered, and the former price is low compared with what had to be paid even a month ago. Probably £5 10s. delivered would be accepted by the Midland furnaces for a large lot delivered over four or six months; but the consumers of foundry iron here are all convinced that much lower prices will be current before six months are over; and, indeed, if a consumer wanted to place a large order for forward delivery, he could do better with a merchant firm than with any of the furnaces. Scotch iron comes down only very slowly, and the difference here between Scotch and common iron prices tends rather to increase than to diminish. Of course, this is partly because the transport charges are so extravagant. Many people believe that the high cost of transport is a burden which the iron trade of this district cannot bear. It is certainly true that Manchester is severely hit by these charges.

Steel.

The market for finished steel is in much the same condition. Import business from the Continent is falling off, and one does not hear much about it now; but the orders received by the British works are too small to be satisfactory. There is some talk of big work requiring steel being in contemplation, but, if so, the Scottish works, being free from the obligation to charge fixed minimum prices, will have a better chance of getting the orders, unless the whole of the steel works in the country are also released from this obligation.

Scrap.

The market for iron and steel scrap is very quiet here. Practically nothing is being done in wrought iron and steel, and the prices remain nominal at from £3 to £3 10s. per ton. A little business is passing in cast iron—foundry—scrap at rather lower prices; but they are still far higher in proportion than those for wrought iron and steel scrap. Possibly good shell scrap might be bought at less than £5 per ton; but for machinery scrap from £5 5s. to £5 15s., according to quality, is asked.

Manchester's New Lord Mayor.

In electing Councillor E. D. Simon to the Lord Mayoralty of the City of Manchester, the Corporation has made a happy selection. Mr. Simon is head of the well-known engineering firms of Henry Simon, Limited, and Simon Carves, Limited, and although a young man for such a position, he has a very wide experience, having been on the City Council for about nine years. He was educated at Rugby and Cambridge, where he took First-class Honours in the Engineering Tripos. As head of the above firms, he has travelled twice round the world. In 1919 he was elected chairman of the Housing Committee of the Corporation. He is a member of the Departmental Committee of the Ministry of Health, which was set up under Lord Newton to advise the Government on means of reducing the smoke nuisance in large centres of population. Mr. Simon speaks well and has lectured at the London University on industrial subjects. It is gratifying to see that in Manchester, at any rate, there are engineers who take an active interest in municipal matters, for Mr. Simon is not the only engineer on the City Council. The opinion is widely held here that it would be all to the public good if more members of the engineering profession would come forward and lend a hand in civic matters, as there is probably no profession more fitted for this class of work.

Manchester Ship Canal and the Cotton Trade.

Speaking at a public function in connection with the Manchester Cotton Association a few days ago, Captain Bacon, chairman of the Manchester Ship Canal, said that the Canal, like the cotton trade, was in a bad way at present. He said that from all the ports of America this year they had received 30,085 bales of cotton, against 20,123 bales last year, which was a bad year. From Galveston, their principal port, they had received only 12,700 bales. On the passage from Galveston they had some 26,600 bales, a considerable decrease up to November. Of Egyptian cotton, they had received this year 37,660 bales, against 12,062 bales last year. During October 175 vessels arrived in the Canal from all parts, against 145 last year, an increase of 30 vessels. As regards the stock of cotton in Manchester, Captain Bacon said they had only 66,000 bales compared with 79,000 bales last year at this time.

Institution of Mechanical Engineers.

There was a very satisfactory attendance of members of the North-Western Section of the above Institution to hear Dr. Hele-Shaw present his Thomas Hawksley Lecture on "Power Transmission by Oil" at the Memorial Hall, Albert-square, Manchester, and although much of the matter contained in the address was already familiar to the majority of those present, the manner in which the author dealt with his subject proved highly entertaining. This remark applies especially to that portion of the lecture which had to do with lubrication. The apparatus used for this portion of the lecture was the same as that employed by the author in London on November 4th. The curves showing the effect of pressure on the viscosity of the various kinds of lubricating oil and water formed one of the most instructive portions of the lecture, and will doubtless be the means of drawing much more attention than hitherto to the importance of this phase of the lubricating problem. The experiment showing how the incompressible nature of oil could be destroyed by the introduction of air bubbles, and the consequent formation of froth, demonstrated the necessity of keeping air out of oil when that liquid is used for power transmission purposes. Mr. Charles Day presided over the meeting, and amongst those present was Captain Sankey, the President of the Institution, who briefly addressed the members, and expressed the gratification of the Council at the success which was attending the formation of the local sections. He promised that any difficulties in connection with their successful operation should be removed.

Manchester Association of Engineers.

There was a very good attendance of members of this Society at its meeting on Saturday last to hear Mr. Harold F. Massey's paper on the "Flow of Metal during Forging," and the paper was followed by a discussion which showed that some of Mr. Massey's views were open to criticism. Whatever the views of the speakers may be on the findings of the author, however, there can be no two opinions concerning the amount of work and thought which the compilation of such a paper involves. In carrying out his experiments, the author made very extensive use of models of coloured wax to show the flow of the metal under the effects of the hammer and press, and the results were illuminating. The experiments showed fairly conclusively that the flow is always greatest near the centre of the forging, and that there is very little difference in this respect whatever the size of hammer or press or the number of blows or squeezes. Mr. Massey said there were two factors present which retard the flow on the outside of a forging, namely, the surface friction and surface cooling of the palletts. The former he succeeded in minimising by the use of oil and graphite on the surface of the palletts, and the effect was to reduce the difference in flow between the centre and outside portions. With regard to the effect of surface cooling, the proof of this was forthcoming by comparing the flow at the top and bottom of the forging in the hammer and in the press. It was seen that difference in the flow was more marked in the hammer than in the press, owing to the difference in the time of contact.

College of Technology—War Memorial.

There was a touching function at the Manchester College of Technology on Friday last, when the unveiling and dedication of the memorial to the members of the College who fell in the war were performed by Mr. J. H. Reynolds, Past-Principal of the College and Dean of the Faculty of Technology. The memorial comprises two tablets of graceful design, upon which are inscribed the names of those who made the Great Sacrifice, as well as those of the College who joined the Forces.

BARROW-IN-FURNESS, Thursday.

Hematites.

Business in the hematite pig iron trade remains very quiet, but there is rather a better feeling, consequent upon the reduction of 10s. in the price of West Coast hematite. Thus the margin between buyers and sellers is gradually being decreased. In the meantime, users are only placing orders to cover their immediate wants, and no more. Apart from the lessened prices quoted, the position is very far from normal, and no general resumption of business is looked for until well into the New Year. At present the production is low. The iron made is going into direct use, local steel makers taking supplies direct from the furnaces. Last week a shipment of pig iron was made from Barrow to Italy, the cargo also including hematite iron ore.

Iron Ore.

With the small number of furnaces in blast the call for hematite iron ore is of necessity small, and the trade is almost wholly confined to local smelters. At the mines there is no further increase in activity to note. On the other hand, foreign ores continue to arrive in Barrow, and the stores held—at one time large—are being rapidly depleted.

Steel.

In the steel trade there is a fair amount of industrial life, and this is likely to be maintained during the remainder of this year. Rails are the chief output, but some of the other departments are employed, including the foundries. Steel all round is in very quiet demand. Prices, however, will be brought down pretty soon, and this may induce new trade. For the making of hoops, French billets are being imported, and a cargo of steel rods has arrived from Belgium.

Shipbuilding and Engineering.

These trades are very quietly employed. On the shipbuilding side of the trade there is little being done, and the stocks at Barrow are almost empty. On Tuesday Vickers Limited launched at Barrow the oil tanker Scottish Minstrel. She has been built for Tankers, Limited, and is the third launched at Barrow for the same employ. Her carrying capacity is 10,050 tons, and she will be fitted with Vickers solid-injection internal combustion engines. The engineers are on short time.

Fuel.

For coal and coke there is a very limited demand.

SHEFFIELD.

(From our own Correspondent.)

Washington's Proposals.

THE poor armament companies! No one, of course, would think of denying the wisdom of any really sound practicable means of reducing the risk of international warfare and at the same time relieving the heavy burden of taxation under which the world is groaning. That is good common sense; but somehow it is always the armament firm that is called on to make the greatest sacrifice. For years before the war these companies spared no expense in building up armament-making departments second to none in the world and in enrolling on their staffs the most highly skilled men; but it was always foreign admiralties rather than our own Government that made these departments—which were, indeed, national assets—financially possible, and many a snub have individual firms received which pressed for orders when difficulty was experienced at times in keeping staffs together through lack of work. But for foreign contracts it is doubtful if some of the companies could have carried on, so far as the armament departments were concerned. Just before the outbreak of war the output of these firms was about equally divided between munitions and peaceful productions, the latter proving by far the more profitable proposition. As the war developed, the armament firms had gradually to jettison their valuable industrial connections, which became distributed over a wide area, many of them falling permanently into the waiting hands of smaller firms, but most of them going to foreign rivals. With the signing of the Armistice and the cutting off of the call for munitions, one-half of the total plant of armament firms was rendered useless, as it was too massive and specialised to be adapted to industrial production, and the other half was entirely dependent on the ability of the managements to win back some, at least, of the lost business of peaceful manufactures. Everyone knows the struggle that was commenced and with what relief Sheffield learnt of the Government's decision to build four battle-cruisers, in the work of which the city was to have a very considerable share. Metaphorically, decks were cleared for action, preparations rushed forward, and with the new year it was anticipated the armament departments would be getting nicely into their old stride. Now comes the suggestion that these operations should be stopped as part of the proposed disarmament reduction plan.

Question of a Subsidy.

As I have already said, there is no denying the rightness of the proposal, but somehow that brings no immediate sense of comfort to Sheffield, which knows very well, as one of the leading manufacturers stated in an interview this week, that the Washington scheme will mean for its great firms a tremendous sacrifice. There are thousands of men idle to-day whose hopes have been stayed on the prospect of "plenty of work after Christmas," and now those hopes are vanishing into thin air. It is also true that some firms, severely feeling the financial strain, had looked to their part in the new naval contracts as almost the hope of salvation. What these people are going to do, should the proposals be carried, it is difficult to foresee at the moment; but the whole idea has been brought home with such startling suddenness this week that it is next to impossible to get manufacturers' tongues loosened. It is not the armament firms only, of course, that will feel the sacrifice, but innumerable others which had already begun to lay plans on the certainty of sub-contracts arising out of the main orders placed. Only a few of the men chiefly affected have spoken out on the subject so far, but prominent among them is Mr. W. L. Hichens, chairman of Cammell, Laird and Co. Mr. Hichens, as usual, takes a very wide, generous view, absolutely devoid of a selfish standpoint, and sees in the Washington proposals a move in the right direction. He cannot help, however, betraying some little anxiety as to what may happen to such a magnificent armament-making plant as that possessed, for example, by his own company, and he raises the question of a subsidy, as a very practical form of insurance, if so be the armament plants are to be kept idle for a decade.

Where Sheffield Stands.

Ten years! Who knows what evil spirit may have broken through the world's desire for peace long before the expiration of that period? Mr. Hichens did not put it exactly in those words, but that was what he seemed to imply. It would not only mean keeping the armament plant intact with a skeleton staff, but the incidence of engineering changes and discoveries would probably necessitate frequent replacing of certain parts of the plant, at huge expense, if it was to be kept constantly up to date. The day may come when a plant of the latter description will again be regarded as a great national asset, but armament firms could not possibly bear the cost of that maintenance without an adequate subsidy, the payment of which would help to equalise the burden, to distribute the weight of sacrifice, and thus make the latter more clearly understood and appreciated by those who so promptly, and quite correctly, endorse a policy of partial disarmament. Otherwise the armament plants of Sheffield would have to be taken down and broken up—a very much easier process than that of building them up to their present magnificent proportions. I have tried in these notes to show just where Sheffield stands in the matter of reduced armaments. Not a voice will be raised against the Washington proposals, but a strong demand will be made that from the same Conference there shall emanate plans by which the fair thing would be done to armament firms, which for years past have faithfully and successfully worked out the policy of the Admiralty to the last detail. However, at the moment of writing, there was a feeling that something more definite should be known before further expression of opinion was made. In other words, that it is the conclusion of the debate on the subject rather than the beginning of it that really matters; though in the meantime the fact is not lost sight of that in the event of the Washington proposals being carried through in their present form, Sheffield would be faced with the necessity of at once reorganising its great steel works with a view to a 50 per cent. expansion of peaceful manufactures, for which markets would have to be found somewhere.

Cheaper Gas for Furnaces.

Turning from that very burning subject—almost the only one, in fact, that is being talked of here this week—there is another matter to which I would like to draw attention, viz., the decision of the Sheffield Gas Company to lower the price of gas. Household consumers, naturally, will welcome the reduction in price of a penny a therm, which is equivalent to a reduction of 5d. per 1000, making the price of Sheffield gas equal to 3s. 7d. per 1000 cubic feet instead of 4s. per 1000; but it is the industrial consumer, who will appreciate the change most of all, for of late years the number of gas furnaces for various annealing, re-heating and other purposes has enormously increased. Sheffield gas has always been cheap compared with other towns, but the reduction, which comes into operation with the new year, is specially acceptable at this juncture when in every direction prices are being trimmed down and every nerve is at straining point to reduce the cost of production by every available means. The present reduction may have some connection with the development of schemes for bringing coke oven gas into the company's mains, for this gas can be sold by the coke oven people at very low rates, and it is of a quite excellent quality for both industrial and domestic purposes.

General Conditions.

As to general conditions—well, when I was discussing this point with a manufacturer he retorted: "There are none." But a reply of that kind is all right so far as it goes. The only trouble is that it does not go very far. There are general conditions capable of being gauged and the indications, apart from the threatened naval contract set-back, still point fair to a gradual recovery. Firms that have been feeling the stress of the last few months very seriously are now beginning to talk of seeing their way through, though there is no doubt a good deal of dirty weather may be experienced yet before smooth waters are reached. There is a much greater tendency for inquiries to materialise into actual business, but the orders, in the main, are for comparatively trifling quantities, involving a great deal of trouble and book-keeping with relatively small revenue returns. Manufacturers find buyers are still very reluctant to "let themselves go." Nevertheless, taken on the whole, there is a fair amount of work in hand, and now it is being realised that iron and steel prices are about at the bottom of the market an improvement should be looked for in the matter of freer movements in forward business. In the North Lincolnshire district, where things have been very bad for a long time, Lysaghts have re-started a couple of furnaces, I hear, though, on the other hand, the Butterley people, in another direction, have had to damp down a furnace again. No doubt iron makers are feeling severely the large stocks of foreign material which are either already here or are to be delivered in the near future, though there is very little margin of a favourable character now between the home and continental article, while no question is possible as to the superiority of the former. It is unlikely that more than one-third of the open-hearth furnaces are in commission, but there is talk of many additional ones coming into operation after the turn of the year. I hear very good accounts of Sheffield firms' experiences at the Motor Show, in one case sufficient orders having been booked for special steels to cover some months ahead. The crucible furnaces are still suffering severely from the slump, and in files, saws and all kinds of tools it is said that the keenest description of competition between various firms is springing up, reminiscent of the old pre-war throat-cutting days.

NORTH OF ENGLAND.

(From our own Correspondent.)

The "Scrapping" Plan.

THE sweeping proposals of Mr. Hughes, at the Washington Conference, have given rise to considerable discussion in commercial circles in the North of England. The abandonment of Great Britain's big ship programme would mean the cancelling of work entailing a loss of several millions in wages for Tyneside workmen at a time when unemployment is so prevalent, the contract for the building of a vessel of the improved "Hood" class having been secured by Swan, Hunter, Wigham Richardson at Wallsend, and the machinery for which is sub-let to Messrs. Parsons, also of Tyneside. Sir George Hunter, head of Swan, Hunter, Wigham Richardson, estimates that at least 6000 men would be engaged on the ship, engines and armament. The actual construction has not yet been started, but it is in the drawing-office stage. While the Tyne would be seriously hit by a ten years' naval holiday programme, if adopted, it should not be overlooked that the chief industries have shown remarkable versatility in changing from war to peace conditions. Aready Armstrong, Whitworth and Co. have turned extensive shell-making works into locomotive shops. The effects of a general limitation of armaments, however, would mean another vast change in plant at Elswick and other establishments on the Tyne. The Wear and Tees are essentially commercial shipbuilding centres, and would not be affected much by the proposals.

Cleveland Iron Trade.

The position in the Cleveland pig iron trade is most discouraging. Business has reached a very low ebb. Price cuts have utterly failed to stimulate demand, and the fact seems to be that many of the foundries are so slack that they will not consider offers of iron at any price. Of course, on the other hand, it will be possible, if further economies can be effected, to stop the invasion of the home market by continental producers, and already the flow of iron from abroad seems to have been checked. But high delivery charges from Cleveland to Scotland still make the foreign iron a little cheaper to Scottish consumers, although there is not now a great deal of difference. The trouble is, however, that all consuming works are suffering from the industrial depression, and it is futile to think of blowing in more furnaces until more orders are in sight. At the moment the disposition is rather to slacken than to increase production, for most of the works have accumulated heavy stocks. Prices show no change, and none is expected until fuel and railway rates are cheaper. It is reported, however, that merchants are prepared to shade recognised market rates in order to secure orders for delivery a long way ahead. No. 1 Cleveland foundry iron is quoted 115s. per ton, No. 3 G.M.B. 110s., No. 4 foundry 105s., No. 4 forge 100s., and mottled and white about 97s. 6d. per ton. In the case of Nos. 1 and 3, a 5s. premium is asked when the iron is for export.

Hematite Pig Iron.

Fair quantities of East Coast hematite pig iron are still being delivered to South Wales, but generally the demand is only for very small parcels, and production exceeds the demand. Naturally, under such circumstances prices are weak, and as there is no price agreement to bolster up quotations, the current rate is somewhat indeterminate. Even for small lots no more than 120s. is quoted for No. 1, and 117s. 6d. for mixed numbers; but for any substantial order the price is a matter for negotiation, and probably even 115s. would be shaded for a reasonable quantity of mixed numbers.

Iron-making Materials.

The foreign ore trade continues in a lifeless condition. Consumers are even reluctant to take deliveries of ore already bought, and there is extremely little new business, even though sellers are willing to make price concessions. The nominal price of best Rubio ore is still 27s. c.i.f. Tees. It is difficult to elicit a quotation for furnace coke because of the absence of any business. If a definite order could be placed, makers are prepared to meet buyers, and business could, it is understood, be placed on the basis of 30s. per ton delivered at the works for good medium furnace coke.

Manufactured Iron and Steel.

Little change of moment is reported in the manufactured iron and steel trade. Some apprehension is felt as to the probable cancellation of the big warship contracts as the outcome of the Washington Conference, for it is recognised that if that course be adopted the steel trade will be badly hit. Considerable interest and much misconception seems to have been created by the reports of the abolition of the price agreement in the steel trade. For some time past there has been a free market abroad, and quotations to foreign consumers under the influence of world-wide competition have been on a lower basis than to home buyers, prices in the latter case being fixed by the associated makers. There has, however, been a little rift in the lute. The Scottish makers are reported to have broken away from the combine, and are now quoting independently both in the home and foreign markets. For the time being North of England makers are adhering to the price agreement, but whether it will survive the shock remains to be seen. Meanwhile the only change in prices is that galvanised sheets are 10s. cheaper at £18 10s., and there is a brisk demand.

The Coal Trade.

The general position of the Northern coal trade remains largely unaltered, with the volume of trade actually passing severely curtailed. Some rather large inquiries from India and the coaling stations, as well as South America and France, have been in circulation, but nothing much has resulted as yet, though hopes are entertained that some of the orders may reach the Northern coalfield. The cold weather does not seem to have accelerated the demand to any appreciable degree, and altogether the collieries are experiencing a very lean time. Opinion is divided as to whether the worst has been passed, but there is certainly not much tangible evidence of any recovery, and the general outlook for the rest of the year leaves very much to be desired. There is an abundance of every class of coal and the supply is considerably in excess of the possibilities of the prompt market. This fact renders competition very keen, and prices very weak in almost every instance. All kinds of steam coals are slow of sale, and discounts can be obtained in every case for prompt trade. The gas coal and coking sections are dull and dispiriting, with the poorer brands a drug on the market. Bunkers are in a poor position, and all sorts of prices are possible from about 20s. 6d. to 24s., according

to class, though at any price the trade offered is very limited. The coke market is quite unimproved. Best beehive is rather scarce, but is obtainable at minimum figures, while patent oven coke is plentiful and in slow request. Gas coke continues steady with a ready market for the entire production.

SCOTLAND.

(From our own Correspondent.)

American Proposals and the Clyde.

THE fate of the American proposal with regard to limitation of navies, involving a ten years' cessation in construction, is of tremendous interest to Clydeside shipbuilders and engineers. The Admiralty contracts just placed were hailed with considerable satisfaction, and certain arrangements have already been completed to commence part of the work immediately. These contracts mean work for thousands of men for a considerable period, and the stoppage of naval construction therefore would be a serious occurrence in such times as these. Consequently, the decision at the Conference is fraught with vital interest for Clydeside industries.

New Admiralty Contracts.

Apart from the Admiralty work already referred to, it is pleasing to note that the Motherwell Bridge Company has secured a contract for the erection of steel work abroad on behalf of the Admiralty. It is said that the securing of this contract is all the more a matter for satisfaction in view of the fact that the firm in question had been able to maintain its activities throughout the war and since the cessation of hostilities, but was now within a month or two of completing all the work on hand. This new contract, however, secured in face of keen competition, will provide work for a considerable period

Pig Iron.

Though the outlook may be a little better, the actual turnover in pig iron is still very restricted. Only some eighteen furnaces are in operation—two making hematite and sixteen foundry qualities—but the production is not fully taken up, and there has been some talk of reducing the number of furnaces, unless an early increase in orders is apparent. Quotations still show a tendency to ease, and are, for some qualities, now within measurable distance of competitive prices. Consumers, meantime, are chiefly buying small quantities which are absolutely required, and are utilising imported material as far as possible.

Steel and Iron.

Though the placing of the Admiralty contracts has already caused a certain amount of activity in steel circles, the trade in general is exceedingly slack. A prominent firm has closed down one establishment during the past week. Thus, while business opens up a little in one quarter, works are closing down in another. Inquiries are plentiful enough, but few orders materialise. In some quarters the attitude of Scottish makers towards prices is held blameworthy, the higher quotations for Scotch material as compared with English products being instanced as evidence of the determination of makers in this district to uphold values, thereby placing local consumers at a distinct disadvantage compared with districts across the Border. On the other hand, it is said that the situation is more hopeful in view of a slowing down of deliveries from the Continent, and the probable diversion of orders to home works. It is also said that some of the material recently imported was not above suspicion. The ironworks, too, are poorly placed. Bar iron makers have booked a few orders, but little expansion can be expected while the basis price remains at £14 per ton for home delivery. Export at £13 5s. is also pretty hopeless. Engineering shops are on short time, and steel and iron tube mills are similarly placed.

Coal.

While more pits have been re-opened, the situation is most unsatisfactory, as the volume of business is not increasing as was anticipated. In view of the colder weather, the house coal trade has increased a little, but in other departments home sales are poor in the extreme. Industrial sorts are very neglected, while railways, &c., are only purchasing immediate requirements. For export, ell coal and Lothian screened are still showing a fair turnover, but other descriptions are slow to move. Small stuffs are especially idle, apart from a spurt in single nuts from Fifeshire. Though a few good consignments of round coal have gone from the Clyde and the Forth to foreign destinations, the bulk of the business is yet of a coastwise nature. Aggregate shipments for the past week were 184,141 tons, against 176,015 tons in the preceding week, and 347,908 tons in the same week in 1913. While prices do not show much alteration, the tone is decidedly weaker, and especially in the case of small stuffs much easier terms can be arranged for good orders.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Inquiries.

Apart from the inquiry for the Brazilian Central Railways, mentioned last week, others have come along from India and Japan, but it is difficult to say as yet whether anything will come of them. Interest has centred more upon the British Admiralty inquiry to which a brief reference was made last week. Very short notice was given to the collieries to send in their tenders, but later information shows that perhaps a too optimistic view was taken as regards the probable quantity that is likely to be taken for delivery over next year. The fact has to be borne in mind that the Admiralty has a fair amount of arrears of coal to take out on existing contracts, and, furthermore, it must not be forgotten that the Navy is yearly becoming a larger consumer of oil, which, of course, is detrimental to the interests of the South Wales coal trade. This and the likely reduction in armaments cannot improve the outlook. Altogether the view is that the present requirements of the Admiralty are not likely to run to more than half a million tons as against a million and a quarter, as was the case before the war. In those days the entry into the market of the Admiralty caused a little flutter because the prices tendered were taken by exporters and consumers generally as a guide to the idea of coalowners regarding values over the following year, and they were then more disposed to go in and book their requirements, feeling safe that they would not be far wrong. Of course, due consideration was given to the fact that coalowners were inclined to make some concession in price to the Admiralty, for the reason that collieries prefer to get this kind of business on their books, as they know that the coals will be taken out fairly regularly and it is something they can rely upon. Furthermore, there is no financial risk, which nowadays is of even greater importance in view of the uncertain conditions prevailing abroad. At the same time the reduction in the probable quantity that will be contracted for by the Admiralty cannot be regarded otherwise than as disturbing, as coalowners will be compelled to look farther afield for buyers, and, as everyone knows, business is attended with the greatest difficulty.

Miners' Wages.

A good deal is heard in one quarter or another as to the best way of reviving the coal trade. The righting of the foreign exchanges, the stabilising of coal prices themselves, and the improvement in industry in general are important matters, but there is the problem of labour, which is always with us. If wages are at such a low level as to be unhealthy and cause dissatisfaction, then there is always the danger that business will be disturbed, and there is nothing so harmful to trade as uncertainty, no matter from what source it arises. At the present time there is no little amount of evidence that the miners are restive because of the scantiness of their earnings even when they are employed, and, of course, it is very well known that there are thousands of miners who are out of work. Even assuming that the spirit of brotherhood prevails among the members of the Federation, it is not difficult to understand that those who are engaged begrudge contributing to the support of those who are unemployed, for the reason that the conditions are against their earning anything too much themselves. Few collieries are working regularly, and wages, which are pretty well down to the minimum, are consequently further curtailed. The lower-paid day wage men are undoubtedly very hard hit. Out of the 250,000 men normally employed in the coalfield, close on 40,000 are on the 5s. rate per shift plus percentage, and about 90,000 are paid rates from 5s. to 6s. per shift. A full week's work on the 5s. per shift rate produces less than £1 19s., and the 6s. rate means about £2 6s. 6d., which amounts, however, are subject to various deductions for Federation contribution, health insurance, unemployment insurance, doctors' fund, &c., which altogether absorb about 2s. 6d. per week. Assuming that the men only get on an average three or four days' work per week, it can easily be figured out what their earnings are like, and it is not surprising that, as the Government has definitely declined to subsidise the industry, the miners' leaders are turning their attention to what can be done in their own districts with the coalowners in order to assist the lower-paid day wage men. The District Board for South Wales met at Cardiff on Monday, and signed the new district general wage rate agreement. Opportunity was taken by the men's representatives to raise the question of wages. This they were entitled to do under the terms of the national agreement, the question being whether the rates of wages determined in any district provided a "subsistence" wage. The subject of allowances was fully discussed, and much as the owners sympathised with the position, the chairman of the coalowners had to point out that any increases in wages naturally increased the cost of production, and in times like these limited the market for coal, reduced the quantity that could be sold, brought about still less regular working of the pits, which in turn again increased costs until a point was reached when pit after pit made losses which could no longer be borne, and collieries were closed and more men thrown completely out of employment. This would occur at a time when the coalfield as a whole was working at a heavy loss. The men's representatives promised to think the points well over, and in the event of their deciding to proceed with their application they would communicate with the owners' secretary

Trade of Swansea.

The chairman of the Finance Committee of the Swansea Harbour Trust was in a fairly optimistic mood concerning trade when giving his statement as to the trade of the port at a meeting of the Trust this week. He said that for the month of September trade showed an increase of 15,000 tons over August, and of 24,000 tons over September of last year. There was a total reduction in the trade, however, for the nine months ending September of no less than 1,445,000 tons, compared with the same period of last year. The total exports and imports for October showed a very substantial increase of 63,000 tons, compared with the previous month, Coal shipments were improving, and in October they jumped up by 45,000 tons. He pointed out that trade was gradually coming back, but emphasised the fact that transport and dock charges and dues must be reduced. The shipments of tin-plates and galvanised sheets had also very much improved. Additional mills were being re-started, and blast-furnaces blown in, and there was a general feeling of optimism that sooner or later they would see the tide of prosperity flow back.

Dry Dock Amalgamation.

Shareholders of the Mountstuart Dry Docks, Limited, of Cardiff, are shortly to meet to consider a scheme for the amalgamation of their interests with those of Mordey, Carney and Co., Limited, of Newport, John Shearman and Co. (Newport), Limited, and John Shearman and Co., Limited, Cardiff. The interests of these companies have for some time been interlocked, as the chairman of all the concerns is Mr. Frank Shearman. The scheme is that the whole of the net assets of the three companies concerned, excluding investments and house property, be acquired by the Mountstuart Company for £475,000; that the purchase price be satisfied by the allotment to the vendors of 475,000 shares in the Mountstuart Company of the nominal value of £475,000 in fully paid deferred shares; and that the sale and purchase take effect as from July 1st. It is proposed that the capital of the Mountstuart Company be increased from £300,000 to £875,000, and that the shares, which are of the denomination of £10, should be split into shares of £1 each.

Current Business.

The market has for the most part been dull, and under the influence of a very meagre inquiry prices have further given way, this being the case more with large steam coals. Colliery salesmen have had to face the ever-present difficulty of finding an outlet for standing coals in order to enable their pits to avoid stoppages as far as possible. Many have, of course, not succeeded, and where they have, it has been at the cost of a reduction in price to get prompt orders. As expected, the Norwegian State Railways have purchased 20,000 tons of Lambton South Hetton coals, but have bought one small cargo of best steam coals from this district, the coals from the North having to be shipped this month and next.

Latest News from the Provinces.

WALES AND ADJOINING COUNTIES.

Coal Contract.

THE report is current that a contract for 150,000 tons of Admiralty coals for India has been concluded, the period of delivery being over next year. Three well-known Cardiff firms are understood to have succeeded in securing the business at the price of about 42s. 6d. net c.i.f. Bombay.

Minimum Wage Claims.

Serious trouble is apprehended in the Maesteg district arising from claims for payment of the minimum wage not having been satisfactorily met. According to one leader, a state of tyranny is being practised throughout the coalfield. The Executive Council of the Federation was to hold a special meeting concerning the matter yesterday (Thursday), but if the Executive takes no action, all the men at North's Navigation and Celtic collieries have decided to tender fourteen days' notice.

Swansea Metal Exchange.

Although there is no distinct improvement in steel and tin-plate business, still the prospects for the new year are looked upon as very hopeful. Prices of tin-plates show no appreciable change, but it is reported that an important order for supplies for British Columbia has been secured by Welsh makers in spite of American competition. The first consignment is expected to be loaded at Swansea very soon. The low freight rate of 40s. per ton from South Wales to Vancouver direct is understood to have helped Welsh makers to secure the contract.

INSTITUTION OF ELECTRICAL ENGINEERS.—Arrangements have been made for the members of the Institution of Electrical Engineers to dine together at the Engineers' Club, Coventry-street, W., after the ordinary meeting of the Institution, to be held on December 1st. The charge per cover is 5s. 6d. Members wishing to be present at the dinner are requested to send their names to the secretary a day or two in advance, either in writing or by telephone.

COMMERCIAL RESEARCH FELLOWSHIPS.—The Executive Council of the British Empire Exhibition announces that it has approved of a scheme for the granting of five or more commercial research Fellowships for competition among chambers of commerce in the United Kingdom. The value of each Fellowship will be not less than £500, and will include a first-class return ticket to the Dominion, Crown Colony, &c., to which the Fellow will proceed. The subjects of research will be as follows:—(1) The best means of promoting inter-imperial trade in a selected staple industry. (2) The methods whereby the British Empire Exhibition can further the interests of this trade. (3) The potential resources in raw materials, &c., in the Dominion or Crown Colony visited, and the best means for exploiting these in the mutual interest of the Dominion and this country. (4) The means whereby these undeveloped resources may be adequately represented at the British Empire Exhibition and brought to the attention of interested financial or industrial groups. The right of nomination for the Fellowship will be placed in the hands of the committee of the chamber of commerce the members of which have collectively provided the highest *per capita* aggregate in guarantees for the British Empire Exhibition subject to the proviso that in any city where the aggregate of guarantees has already exceeded £50,000 one such Fellowship shall be assigned to the committee of the chamber of commerce. The selected candidate should be preferably either himself a member of the chamber of commerce or should be in the employ of a firm which is a member. The particular subject for investigation will be determined by the local chamber of commerce, but in order to prevent any overlapping, not more than one Fellowship will be tenable in the same Dominion, Crown Colony, &c., and in the event of two or more chambers of commerce selecting the same subject for investigation, and being unable to agree on alternatives among themselves, the matter will be referred for decision to the president or deputy president of the Association of British Chambers of Commerce. The closing date for entry for the competition on the part of local chambers of commerce will be December 15th. The result of the competition will be announced on or before December 24th, and the successful chamber of commerce will proceed to the election of the Fellow forthwith. The name of the Fellow, and the proposed subjects for investigation, should reach the Secretary, British Empire Exhibition, 16, Hobart-place, S.W. 1, not later than January 14th, and the selected Fellows will be required to proceed to their respective destinations before the end of March, 1922. Before proceeding to his destination, each Fellow will be required to spend an agreed period of not less than a fortnight at the headquarters of the British Empire Exhibition, in order to make himself acquainted with its organisation.

Current Prices for Metals and Fuels.

IRON ORE.

N W. Coast—	
Native	37/-
(1) Spanish	28/-
(1) N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—(2)		
Hematite	6 15 0	—
No. 1 Foundry	6 15 0	—
No. 3 ,,	6 10 0	—
N.E. Coast—		
Hematite Mixed Nos.	5 17 6	5 17 6
No. 1	6 0 0	6 0 0
Cleveland—		
No. 1	5 15 0	6 0 0
Silicious Iron	—	—
No. 3 G.M.B.	5 10 0	5 15 0
No. 4 Foundry	5 5 0	5 5 0
No. 4 Forge	5 0 0	5 0 0
Mottled	4 17 6	4 17 6
White	4 17 6	4 17 6
Midlands.		
Staffs.—		
All-mine (Cold Blast)	17 0 0 to 17 7 6	
Part Mine Forge	*None offering.*	
,, Foundry No. 3	*None offering.*	
Northampton—(3)		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	5 2 6 to 5 5 0	
,, Forge	4 17 6	—
Derbyshire—(3)		
No. 3 Foundry	5 5 0 to 5 10 0	
Forge	5 0 0 to 5 2 6	
Lincolnshire—		
Basic	*Uncertain.*	
Foundry	,,	
Forge	,,	
N.W. Coast—(4)		
N. Lanca. and Cum.—		
Hematite Mixed Nos.	6 15 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	14 0 0	—
Best ,,	17 0 0	—
N.E. Coast—		
Common Bars	14 0 0	—
Marked ,,	18 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	14 0 0	—
Hoops	17 5 0	17 0 0
S. Yorks.—		
Crown Bars	14 10 0	—
Best ,,	17 0 0	—
Hoops	17 5 0	—
Midlands—		
Marked Bars (Staffs.)	17 10 0	—
Crown Bars	14 10 0	—
Nut and Bolt Bars	14 10 0	—
Gas Tube Strip	15 0 0	—
Hoops	17 10 0	—

STEEL.

	Home.(6) £ s. d.	Export.(7) £ s. d.
Scotland—(5)		
Boiler Plates	15 10 0	—
Ship Plates ¾in. and up	11 0 0	—
Sections	10 0 0	—
Steel Sheets ⅛in. to ¾in.	12 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 0 0

STEEL (continued)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 10 0	—
Heavy Rails	10 10 0	—
Fish-plates	15 10 0	—
Channels	14 10 0	—
Hard Billets	9 10 0	—
Soft Billets	7 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	11 0 0	—
Light ,,	13 0 0 to 15 0 0	
Billets	10 0 0	—
Ship Plates	10 10 0	—
Boiler ,,	16 0 0	—
Manchester (*Prices irregular and uncertain unchanged*)—		
(8) Bars (Round)	10 0 0 to 12 0 0	
(8) ,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	17 5 0	17 0 0
,, (Soft Steel)	14 5 0	14 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	
Sheffield—		
Siemens Acid Billets	13 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	10 0 0	—
Soft ,,	8 10 0 to 10 0 0	
Hoops	14 5 0	—
Soft Wire Rods	12 0 0	—
Midlands—		
Small Rolled Bars	11 0 0	—
Bessemer Billets and Sheet Bars	8 0 0 to 8 5 0	
(4) Hoops	13 10 0	—
Tube Strip	11 10 0	—
Sheets (24 W.G.)	15 0 0 to 16 0 0	
Galv. Sheets (f.o.b. L'pool)	18 10 0 to 19 0 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	21/- to 22/6
Block Tin (cash)	157 7 6
,, (three months)	159 7 6
Copper (cash)	66 15 0
,, (three months)	67 12 6
Spanish Lead (cash)	24 7 6
,, (three months)	23 17 6
Spelter (cash)	25 17 6
,, (three months)	26 12 6
Manchester—	
(9) Copper, Best Selected Ingots	69 0 0
(9) ,, Electrolytic	75 0 0
(10) ,, Strong Sheets	101 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 4½
Lead, English	25 5 0
,, Foreign	24 5 0

(*Metal prices practically unchanged*).

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23	12/-
,, 6 p.c. to 8 p.c. ,,	£26	10/-
,, 8 p.c. to 10 p.c. ,,	£26	10/-
,, Specially Refined		
Max. 2 p.c. carbon	£79	28/-
,, 1 p.c. ,,	£94	32/-
,, 0·75 p.c. carbon	£110	41/-
,, carbon free	2/8 per lb.	
Metallic Chromium	5/6 per lb.	
Ferro Manganese	(per ton) £18 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
,, ,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	21/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/6 per lb.	
Nickel (per ton)	£190	
Cobalt	14/6 per lb.	
Aluminium (per ton)	£110 to £120 (British Official).	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	24/-
,, ,, Ell	26/-
,, ,, Splint	25/- to 30/-
,, ,, Trebles	25/6
,, ,, Doubles	22/-
,, ,, Singles	18/-
Ayrshire—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	25/-
,, ,, Trebles	25/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	19/6 to 23/6
Screened Navigation	25/6
Trebles	25/-
Doubles	21/6
Singles	18/-
Lothians—	
(f.o.b. Leith)—Best Steam	22/6
Secondary Steam	21/6
Trebles	25/-
Doubles	22/6
Singles	18/-

ENGLAND.

(11) N.W. Coast—	
Steams	36/6
Household	40/- to 55/-
Coke	36/6 to 39/6
Northumberland—	
Best Steams	22/6 to 23/-
Second Steams	21/6 to 22/-
Steam Smalls	16/-
Unscreened	21/6
Household	25/- to 30/-
Durham—	
Best Gas	24/- to 24/6
Second	21/- to 23/-
Household	25/- to 30/-
Foundry Coke	40.- to 42/6
Sheffield—(12)	
S. Yorks. Best Steam Hards	32/- to 33/-
Derbyshire Hards	31/6 to 32/-
Seconds	30/6 to 31/6
Cobbles	30/6 to 31/6
Nuts	28/- to 30/-
Washed Smalls	17/- to 18/-
Best Hard Slacks	17/6 to 18/6
Seconds ,,	17/- to 17,6
Soft Nutty ,,	17/- to 17,6
Pea ,,	11/6 to 12,6
Small ,,	9/- to 10/-
House, Branch	40/- to 41/-
,, Best Silkstone	37/6 to 39/-
Blast Furnace Coke (Inland and Export)	25/- to 30/-

(13) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	25/6 to 26/-
Second ,, ,,	25/- to 25/6
Best Dry Large	25/6 to 26/-
Ordinary Dry Large	25/- to 25/6
Best Black Vein Large	24/- to 24/6
Western Valley ,,	23/6 to 24/-
Best Eastern Valley Large	23/6 to 24/-
Ordinary ,, ,,	21/6 to 22/6
Best Steam Smalls	18/6 to 19/-
Ordinary ,,	12/6 to 18/-
Washed Nuts	32/6 to 35/-
No. 3 Rhondda Large	30/- to 31/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	24/- to 25/-
,, ,, Through	20/- to 22/-
,, ,, Smalls	15 - to 16/-
Coke (export)	42 6 to 47,6
Patent Fuel	26/6 to 28 6
Pitwood (ex ship)	40/- to 42/6
Swansea—	
Anthracite Coals:	
Best Large	55/- to 57/6
Seconds	52/6 to 55/-
Red Vein	47/6 to 50/-
Big Vein	55/- to 57/6
Machine-made Cobbles	72/6 to 75/-
Nuts	72/6 to 75/-
Beans	58/6 to 60/-
Peas	24/- to 25/-
Breaker Duff	8/- to 8/6
Rubbly Culm	11/6 to 12/-
Steam Coals:	
Large	26/- to 28/-
Seconds	25/- to 26/-
Smalls	12/6 to 16/-
Cargo Through	20/- to 22/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.
(6) Home Prices—All delivered Glasgow Station. (7) Export Prices—F.O.B. Glasgow. (8) Prices represent the real market before the *official* change was made.
(9) These prices are practically alike now. (10) Sheets reduced while other prices are advancing.
(11) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (12) For inland sales. (13) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Eight Hours' Day.

At the time the International Conference on Labour decided on recommending that all allied countries should adopt the eight hours' day France was the first to put it into practical operation. The eight hours' day can now be legally enforced in all industries, and the fact that the rule is more honoured in the breach than in the observance is proof that the general application of the shorter day is impracticable. The conditions in France are less favourable to a restriction of working hours than in most other countries. Apart from the fact that the worker had always been accustomed to put in as many hours as he pleased and rather resented, in the majority of cases, finding himself under the domination of unions which curtailed his liberty of action, it was soon perceived that a measure which could only diminish production at a time when the country had lost more than a tenth of its wage earners and required a superabundance of labour to repair the ravages of the war, must have fatal consequences. On the railways there has been a heavy addition to the charges and a falling off in efficiency. In the merchant marine the extra burden on shipowners is so serious that they are finding it almost impossible to compete with other countries during the present period of low freights. In the agricultural industry the eight hours' day is found to be quite inoperative, and the French Government has been compelled to give instructions to its delegates at Geneva to announce the withdrawal of the agricultural industry from the eight hours' programme. At the recent meetings of the International Conference there was strong opposition to the French attitude, which, however, can avail little, for there is nothing to compel the Government to enforce the law, and so far as the agricultural industry is concerned it has become a dead letter. The opposition at Geneva was aimed more particularly at what appeared to be the failure of a principle. The "contracting out" process will not be confined to agriculture, but will extend to other industries, and already a Bill has been prepared for presentation to the Chamber of Deputies under which those industries in which the eight hours' day may be enforced will be specifically mentioned, while in all other cases the number of working hours will depend upon circumstances and more especially upon an arrangement between the men and their employers. The desire to see an end to the arbitrary fixing of working hours is so general, except amongst the union groups, that the law is largely ignored, and in the construction of the generating stations in connection with the electrification of the State railways the men, for example, are working ten hours a day. The workers themselves have discovered that in eight hours, despite higher wages, they earn relatively less than formerly, because they produce less, and they much prefer to put in extra hours, especially now that wages are coming down.

The Tariff Coefficients.

The imposing of higher coefficients by the French Customs has resulted in complications which are not likely to assist in the development of foreign exchanges. The failure of Belgium to obtain adequate concessions has compelled that country to abandon its Free Trade principles and to enforce a differential system of tariffs which aims at adjusting the duties on German goods in accordance with the depreciation of German currency and at imposing higher duties on French imports to compensate for the facilities provided by the French fiscal system for sending iron and steel and other products into Belgium. The attempt of the French Government to obtain concessions from Belgium under pressure of the higher coefficients has failed. In the same way Spain replied to the increased coefficients by putting up the duties on French products to an almost prohibitive figure. For many months past attempts have been made to come to some arrangement, but as Spain has not replied to the French offers, the Government has formally denounced the existing convention, which means that if something is not done during the next month the maximum tariff will be applied to Spain. As this represents 300 per cent. over and above the minimum tariff, it is obvious that exchanges between the two countries will become impossible. Following upon the collapse of the Spanish negotiations, the convention has also been denounced with Italy, which considerably increased its duties on French goods in retaliation; but as negotiations are still in progress it is believed that a satisfactory solution will be found. The situation is, however, sufficiently serious to cause a great deal of uneasiness, and it has increased the opposition to the Government's fiscal policy, to the extent that the Minister of Commerce has found it necessary on several occasions to protest that the higher coefficients are not an additional measure of industrial protection. He affirms that they merely represent an adjustment of values upon the pre-war basis, but as the coefficients vary from 2 to 6 it is evident that they raise the tariffs to a considerably higher level. So far as British goods are concerned, the coefficient of 2 might be acceptable, since that fairly represents the depreciation of the French currency; but as a matter of fact the depreciation does not mean that the cost of manufacture in France is proportionately less, and while the buying power of the franc in England is only one-half of what it was before the war, it is comparatively higher in France, with the result that the cost of manufacture is about two-thirds of what it is in England. Consequently, the coefficient of 2 is not considered to offer a sufficiently high protection to home industries; out as it is nearly always exceeded and often reaches 4 and even 6 the protective character of the coefficients cannot be denied. The Government is well aware that in view of the resistance offered by other countries, this state of things cannot last indefinitely. It is stated that the coefficients are a temporary expedient and may be revised at any moment, and the extent to which this may be done will depend upon the negotiations in progress with different countries for the carrying out of separate commercial arrangements.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

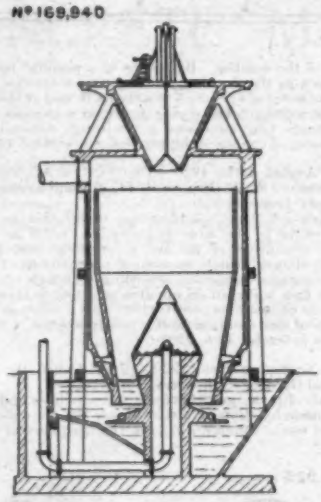
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

GAS PRODUCERS.

169,940. July 3rd, 1920.—Reinforced Concrete Gas Producers, O. R. Verity, 43, Via Santa Reparata, Florence, Italy.

In this specification a claim is made for a gas producer of reinforced concrete in which a body portion of reinforced concrete is suspended from uprights by aid of a reinforcing ring,

N° 169,940



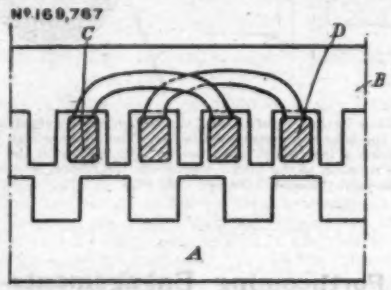
and the body portion carries on its lower border a bell of refractory material, the space between the body portion and the bell being filled with insulating material. The method of construction is obvious in the drawing.—*October 3rd*, 1921.

DYNAMOS AND MOTORS.

169,767. June 23rd, 1920.—Improvements in Two-phase High-frequency Alternating-current Generators, Marius Charles Arthur Latour, of 79, Boulevard Haussmann, Paris.

The rotor core A has polar projections, the peripheral length of which is, by way of example, equal to the interval between the poles. The stator armature B has slots having a width equal to that of the polar projections or spaces of the rotor, and has

N° 169,767



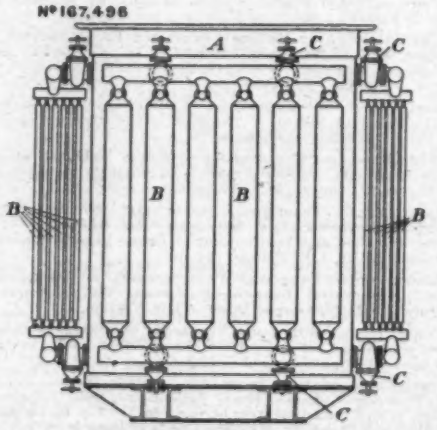
teeth of half that width. Under these conditions, the independent windings C and D may deliver two-phase currents equal to one another, and the frequency is determined by the number of polar projections on the rotor. In each winding the magnetic flux will oscillate between maximum and minimum values.—*September 23rd*, 1921.

TRANSFORMERS.

167,496. August 5th, 1921.—Improvements in Oil-cooled Transformer Boxes, Aktiengesellschaft Brown, Boveri & Cie., of Baden, Switzerland.

Before a transformer is put into operation, its oil must be

N° 167,496



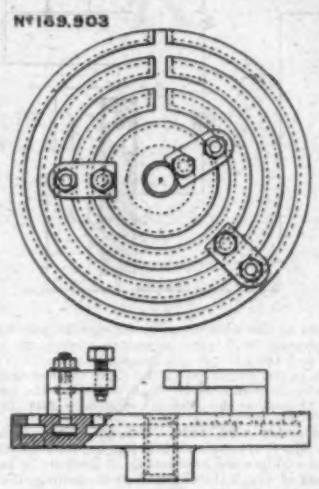
freed from air and water, and this is done by boiling the oil under a vacuum. Frequently, the oil is also boiled after the transformer has been in use. The dimensions of the transformer case must enable it to be placed under a vacuum. According to this invention, the transformer box A has a series of cooling pockets B, which are arranged in groups, and are connected at the top and bottom to the box by means of short pipes or tubes. Sluice stop valves C are inserted in the connecting pipes as shown, and by closing these valves the flow of the oil in the cooling pockets can be prevented. During the boiling out of the oil in the vessel A the sluice valves C are closed.—*October 13th* 1921.

MACHINE TOOLS AND SHOP APPLIANCES.

169,903. September 20th, 1920.—Face Plates, A. Bailey 8t Olave, Long-lane, Church End, Finchley, London, N. 3.

In place of the usual radial slots, the inventor provides his

N° 169,903



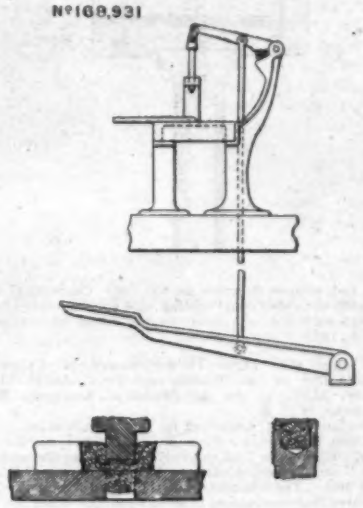
face plate with concentric circular T slots. A gap is left for the insertion of the clamping bolts.—*October 13th*, 1921.

MEASURING AND TESTING INSTRUMENTS.

169,931. January 21st, 1921.—Artificial Jewels for Bearings, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

Artificial jewels for pivot bearings are made, according to this specification, in one operation by punching them out of a

N° 169,931



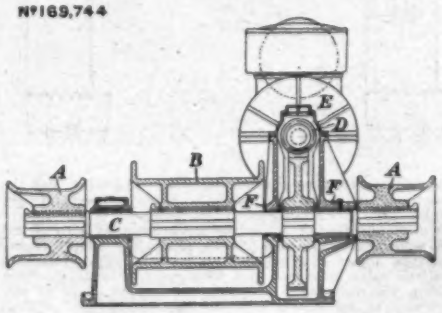
bar of vitreous material, made plastic by heat. The illustrations show the foot press used, the shape of the dies and a finished jewel in its setting.—*October 13th*, 1921.

MISCELLANEOUS.

169,744. May 5th, 1920.—Improvements in Electrically Driven Winches, William Harding Scott, of Gothic Works, Hardy-road, Norwich.

The object of this invention is to provide a winch which, besides being cheap to construct, will occupy a small amount of space. The drum A and the winding barrel B are keyed to the shaft C, and are driven by a worm D on the motor spindle

N° 169,744



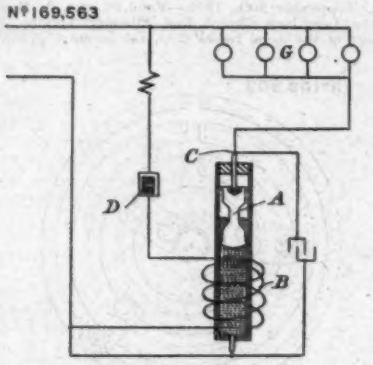
the worm engaging with a worm wheel keyed to the shaft C. The field magnets of the motor are secured to the flanges of a casing connected to the projecting part E of the gear box, which extends from the base of the machine and carries the bearings F for one end of the shaft C, whilst the other end is

supported at its opposite end upon an extension from the base of the machine.—*October 5th*, 1921.

169,563. July 19th, 1920.—Improvements in Apparatus for the Distant Control of Electric Switches by Means of Light Radiations, Ernest Schaetner, of 117, Corringham-road, Golders Green.

A magnetic plunger A, floating in mercury, is attracted by an electro-magnet B, and interrupts the current supplied to the lamps G by breaking the circuit between the top of the magnetic plunger and a contact C fixed above the plunger. A selenium cell D is connected in series with the electro-magnet. When

N°169,563

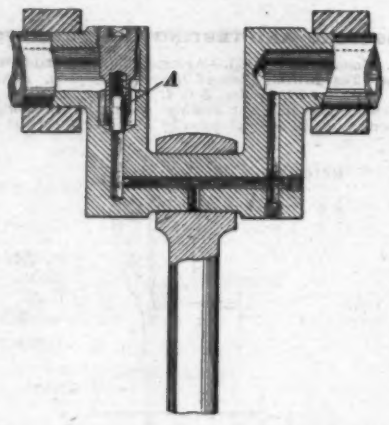


light impinges on the selenium cell, the current passing through the electro-magnet B is large enough to attract the plunger of the switch, and thus break the lamp circuit, whilst when the selenium cell is not subjected to the light the resistance of the controlling circuit is sufficiently high to reduce the pull on the plunger and thus close the circuit.—*September 29th*, 1921.

169,652. December 23rd, 1920.—Forced Lubrication, H. C. Olivier, No. 1, Hooistraat, The Hague, Netherlands.

In order to regulate the lubricating oil pressure in accordance with the speed at which the crank shaft is running, the inventor arranges the valve A in the oil passage. The oil is supplied on

N°169,652

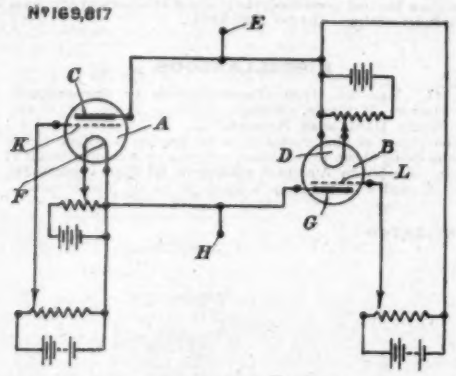


the right and escapes to waste on the left. Centrifugal action tends to keep the valve on its seating, and consequently restricts the passage to waste of the oil as the speed is increased.—*October 6th*, 1921.

169,817. July 6th, 1920.—Improvements in Electrical Resistances of the Thermionic Type, James Erskine Murray, D.Sc., of the Air Ministry, Alexandra House, Kingsway, W.C. 2.

The resistance unit described in this specification is composed of two thermionic valves A and B, each having three electrodes. The anode C of the valve A and the filament D of the valve B are connected so as to form one terminal E of the resistance unit. The filament F of the valve A and the anode G of the valve B are connected so as to form the other terminal H of the resistance unit. The potentials of the grids K and L

N°169,817

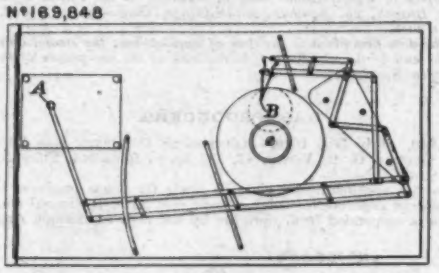


of the respective valves are independently controlled, and the filament currents of the two valves are likewise independently controlled. In this arrangement, the resistance of the unit in either direction is taken across the anode filament path of one valve, while the other valve offers a practically infinite resistance. The object of the invention is to provide a variable thermionic valve resistance unit for currents flowing in either direction, the resistances in opposite directions being of any desired ratio to one another.—*October 6th*, 1921.

169,848. July 15th, 1920.—Apparatus for Displaying Drawings, L. St. L. Pendred, Feltham House, Goldingshill, Loughton, Essex.

When a teacher or lecturer desires to use a blackboard in order to illustrate his remarks by writing or diagrams, it is necessary for him to turn his back upon his pupils or audience, and the writing or diagram is temporarily obscured from view by his body. The principal object of this invention is to provide means whereby a teacher or lecturer may be enabled, whilst continuing to face his audience and to have them in full view to make a diagram or writing, which will be reproduced as he makes it upon a screen situated behind him in such a position that it will be in full view of the audience and unobstructed by

N°169,848



the body of the teacher. By means of a peculiar form of linkwork, shown in the drawing, the inventor transmits the movement of the lecturer's pencil A to a stylus B, and at the same time inverts the writing. The stylus draws on a smoked glass plate and the image thus produced is projected optically on to a screen, where, of course, it appears erect.—*October 13th*, 1921.

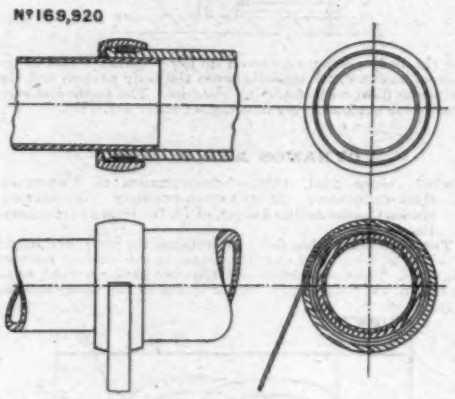
169,884. August 18th, 1920.—Protecting Aluminium from Corrosion, W. B. Brunskill, 21, Jutland-avenue, Cark-in-Cartmel, Lancashire.

There are two long specifications under this number, and the chief claim in the later specification reads as follows:—"(1) The treatment of an article or structural member of aluminium alloy in which aluminium predominates for the prevention of surface corrosion, according to which the article or member is first boiled in an alkaline solution, is then subjected to the action of steam, is next treated with a solution containing phosphates of zinc and iron, and is finally washed to remove free phosphates.—*October 13th*, 1921.

169,920. November 29th, 1920.—Hose Clips, W. T. Groom, Central Garage, High-street, Towcester.

With this clip the joint between the soft hose and the metal fitting is made by slipping a sleeve over the joint and inserting a ribbon of metal through a hole in the periphery of the sleeve.

N°169,920



The sleeve is then rotated, and the ribbon thus wound tightly round the hose in superimposed layers. The hole through which the ribbon is inserted is made tangentially, so that if the direction of rotation of the sleeve is reversed, the ribbon is unwound and the joint released.—*October 13th*, 1921.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Junior Institution of Engineers.—Caxton Hall, S.W. 1. Annual general meeting. 7 p.m.

Junior Institution of Engineers: Midland Section.—Birmingham Chamber of Commerce, New-street, Birmingham. Lecture on "Coal Mining in Great Britain," by Professor K. Neville Moss. 7 p.m.

The Institute of Metals: Sheffield Local Section.—Mappin Hall of University of Sheffield, St. George's-square. Chairman's address: "What is a Metal?" by Professor C. H. Desch. 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, S.W. 1. "The Machinery of Floating Docks," by Dr. E. H. Salmon. 6 p.m.

West Bromwich Engineering Society.—Technical School, West Bromwich. Paper: "Steel Tube Making," by Mr. Fred H. Moseley. (Lantern, &c.) 7.30 p.m.

Institute of Transport: Graduates' and Students' Section.—Royal Society of Arts, John-street, Adelphi, W.C. 2. "The Operation and Development of Urban Electric Railway Services," by Mr. J. P. Thomas. 5 p.m.

Association of Engineering and Shipbuilding Draughtsmen: Merseyside Branch.—Rushworth Hall, Liverpool. Lecture: "The Influence of Music on Life." 8 p.m.

Public Works, Roads and Transport Congress, London.—For programme see page 422. The Congress opens to-day and lasts till Friday, November 25th.

Institution of Gas Engineers.—Public Works, Roads and Transport Congress, Royal Agricultural Hall, Islington. Papers:—(*a*) "Public Lighting by Gas," by Dr. J. S. G. Thomas and Mr. Dean Chandler; (*b*) "The Utility of Benzole for Transport Purposes," by Captain E. De Normanville; (*c*) "Tar for Public Roads," by Mr. Hugh James; (*d*) "The Reduction of Atmospheric Pollution resulting from the Use of Gaseous Fuel," by Mr. J. S. Owens, M.D. 11 a.m.

MONDAY, NOVEMBER 21ST.

Institution of Mechanical Engineers: Graduates' Section.—Storey's-gate, S.W. 1. Paper: "Some Thoughts on Motor Cycle Engine Design," by Mr. John Harrison. (Graduates of Institution of Automobile Engineers invited.) 7 p.m.

Institution of Electrical Engineers.—Savoy-place Victoria Embankment, W.C. 2. Informal meeting. Discussion "Hydro-electric Power," to be opened by Mr. A. J. Hamsworth 7 p.m.

Institution of Civil Engineers: Yorkshire Association.—Y.M.C.A., Albion-place, Leeds. Paper, "Housing," by Mr. G. McLean Gibson. 7.30 p.m.

Royal Institute of British Architects.—9, Conduit-street, Regent-street, W. 1. "School Design," by Mr. G. H Widdows. 8 p.m.

The Petter Engineering Society.—Petter's Institute, Yeovil. "Essential Factors in Oil Engine Design," by Engineer-Commander Sillince, R.N. 8 p.m.

TUESDAY, NOVEMBER 22ND.

Institution of Industrial Administration.—110, Victoria-street, Westminster, S.W. 1. "Unemployment Insurance for Individual Firms," by Mr. H. Lesser. 7.30 p.m.

The Women's Engineering Society.—Club Room, 26, George-street, Hanover-square, W. Lecture, "Women and the Conquest of the Air," by Miss Mary Abbott. Lantern. 6.15 p.m.

Institute of Marine Engineers.—The Minories, Tower-hill, E. 1. "Pictures of the Solar System and a Glimpse of our Universe," by Mr. A. Jobling. Lantern. Ladies' night. 6.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Lecture Theatre, Mining Institute, Westgate-road, Newcastle-on-Tyne. "The Maag Gear," by Engineer-Lieut.-Commander L. J. Le Mesurier. 7.30 p.m.

WEDNESDAY, NOVEMBER 23RD.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "Trueman Wood" Lecture. "The Coming of Age of Long-distance Wireless Telegraphy and some of its Scientific Problems," by Professor John Ambrose Fleming. 8 p.m.

Institution of Electrical Engineers: South Midland Centre.—University, Edmund-street, Birmingham. "Some Notes on the Design of Liquid Rheostats," by Mr. W. Wilson 7 p.m.

Industrial League and Council.—Caxton Hall, S.W. Lecture, "The Industrial Revolution in England," by Mr. H. E. Blain. 7.30 p.m.

THURSDAY, NOVEMBER 24TH.

The Optical Society.—Imperial College of Science and Technology, South Kensington, S.W. 7. Lecture, "The Polariscope, from a Historical Standpoint," by Professor F. J. Cheshire. 7.30 p.m.

Royal Microscopical Society: Metallurgical Section.—20, Hanover-square, W. 1. Opening meeting. It will be devoted to the practical application of vertical illuminators in the determination of the structure of metals and alloys and in metallographical research generally. 7.30 p.m.

The Institution of Locomotive Engineers: London.—Caxton Hall, Westminster. Paper, "Axleboxes and Hornblocks," by Mr. A. E. Kyffin. 7.15 p.m.

FRIDAY, NOVEMBER 25TH.

Junior Institution of Engineers.—Caxton Hall, Westminster, S.W. 1. Lecturette: "Electro-magnetic Instruments; Problems in their Design and Construction," by Mr. G. F. Shotter. 8 p.m.

Institution of Production Engineers.—Institution of Mechanical Engineers, Storey's-gate, S.W. Paper: "Drawings and Production," by Mr. A. F. Guyler. (Lantern.) 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Dominions and Colonies and Indian Sections, joint meeting. "An Imperial Airship Service," by Mr. A. H. Ashbolt. 4 p.m.

The Manchester Association of Engineers.—Memorial Hall, Albert-square, Manchester. Discussion, "Foundry Costs and Establishment Charges," to be introduced by Mr. Daniel Adamson. 7 p.m.

Institution of Locomotive Engineers: Scottish Centre.—Societies' Room, Royal Technical College, George-street, Glasgow. Paper, "The Locomotive from a Footplate Point of View," by Mr. J. P. Grassick. 7.30 p.m.

East London College: Department of Civil and Mechanical Engineering.—Mile End-road, E. 1. Lecture V., on "Diesel and Semi-Diesel Oil Engines, the Present Position of the Heavy Oil Engine and the Problems Involved in its Further Development," by Engineer-Commander B. W. Knott. 6 p.m.

SATURDAY, NOVEMBER 26TH.

Junior Institution of Engineers.—Visit to the Locomotive Sheds of the Great Western Railway at Old Oak Common. 2.30 p.m.

MONDAY, NOVEMBER 28TH.

University of London, University College: Faculty of Engineering.—Lecture on "Geometry for Engineers," by Mr. A. T. Walmisley, M. Inst. C.E. The lecture is open without fee or ticket to students and others interested in the subject. 5 p.m.

WEDNESDAY, NOVEMBER 30TH.

Liverpool Engineering Society.—Royal Institution, Colquitt-street, Liverpool. "Modern Conceptions of Corrosion," by Mr. Wm. Ramsay. 8 p.m.

FRIDAY, DECEMBER 2ND.

Junior Institution of Engineers.—Caxton Hall, Westminster, S.W. 1. Lecturette, "Notes on Maintenance of Electrical Accumulators," by Mr. B. L. Ladkin. 8 p.m.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

We are informed that the old-established engineering firms of George Kent, Limited, London and Luton, and J. Blakeborough and Sons, Limited, London and Brighouse, have made arrangements for merging their organisations under the title of George Kent, Limited, and J. Blakeborough and Sons, Limited. The central sales offices of the two firms will be situated at 199 to 200, High Holborn, London, W.C. 1.

Contracts.—Underfeed Stoker Company, Limited, has recently received orders for twelve travelling grate stokers; two travelling grate stokers and ash hoppers; two ash conveyors and hoppers; three underfeed stokers; and eighteen travelling grates. The majority of the orders were from corporations, &c., in this country, but some came from the Continent and India.—At the Iron and Steel Works of Tamaris, belonging to the Fonderies et Forges d'Alais (France), a 4-ton open-hearth steel-melting furnace, designed by the E. W. Harvey Gas Furnace Company, Limited, of 70, Victoria-street, Westminster, S.W. 1, has recently been set to work, and is now regularly and successfully making steel castings and some special steels. Four charges of steel are, we understand, made per twenty-four hours. The furnace is of the Harvey-Siemens type, with air regenerators only.